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GEOLOGICAL SURVEY OF MISSOURI.

ARTHUR WINSLOW, STATE GEOLOGIST.

BULLETIN No. 1.

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By G. Hamblech, paleontologist.	

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JEFFERSON CITY,
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GEOLOGICAL SURVEY OF MISSOURI.

BULLETIN No. 1.

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STATE GEOLOGIST.

ARTHUR WINSLOW JEFFERSON CITY.

ASSISTANTS.

G. HAMBACH, palæontologist.

G. E. LADD, asst. geologist.

Specialty: Building Stones, Clays, Etc.

A. E. WOODWARD, asst. geologist.

Specialty: Mineralogy and Chemistry.

JAMES D. ROBERTSON, assistant in the Zinc and Lead Regions.

LEO GLUCK, assistant in the Coal Fields.

ELSTON H. LONSDALE, aid.

C. F. MARBUT, aid.

JOHN C. HALLIGAN, clerk.

NOTICE.

This publication is the first of a series of bulletins which it is the purpose of the Geological Survey to issue at intervals. They are not intended to embody final results, nor are they to be taken as reports of progress to date. The material in them will represent such portion of the results of the work of the Survey, as can be provisionally and briefly presented in a serviceable form; the aim will be to make the matter such as the demand is most urgent for. But it must be distinctly understood that no such publication, or series of publications, represents the total product of the Survey's expenditure of money or labor, as is more fully explained in the following administrative report. In the present instance, in addition to what is here presented, a large amount of work, the short time considered, has been done on the zinc and lead deposits of the State, some of the results of which, it is the intention, shall appear in the next bulletin; further, a large part of Lafayette county has been examined and mapped in detail, and similarly portions of Iron and adjoining counties, and work has been done and facts have been collected relating to the geology of Jackson and Johnson counties. A general inspection has been made of the quarry industry of the State, preliminary to future work, and considerable progress has also been made in the examination of the clays in the vicinity of St. Louis. In addition to this a large amount of work has been done in the office in draughting and correspondence, and in the laboratory in the examination and arrangement of specimens.

ARTHUR WINSLOW,
State geologist.

(v)

BULLETIN No. 1,
OF THE
GEOLOGICAL SURVEY OF MISSOURI.
ADMINISTRATIVE REPORT.

By ARTHUR WINSLOW, State geologist.

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THE ORGANIZATION AND PLAN OF THE SURVEY.

The act establishing the Bureau of Geology and Mines was approved May 13th, 1889. The State geologist was elected by the Board of Managers on August 29th, 1889, and entered upon the duties of his office September 20th, 1889.

The location of the Survey headquarters was not decided upon until the beginning of October. This question settled, the State geologist started at once to organize the Survey.

Survey estab-
lished May 13th,
1889.

Operations to
cover the whole
State.

In planning the work it was, from the start, evident that it would not be just nor practicable to examine and report only upon those subjects and areas which had not been reported upon by previous surveys of the State. Fifteen years have now elapsed since such work was done. New developments have been made. Interests which at that date were insignificant are now of great importance. Work of a character sufficient for the needs of that time, is now inadequate. The only rational plan for the Survey to follow was one which would satisfy all existing demands and requirements, as far as the means at disposal would allow.

With this idea in mind the following works are in progress, or will be in progress in the near future :—

THE WORK IN PROGRESS.

Subjects of work.

1. An examination of the zinc and lead deposits.
2. An examination of the coal fields.
3. An examination of the building stones, clays, sands and cements.
4. An examination of the mineral waters.

Ultimate objects.

The ultimate objects of these, and of similar examinations to be made by the Survey in the future, will be to determine, first the origin or mode of formation, second the distribution or horizontal and vertical extent, and third the character and adaptabilities of the substances studied.

THE ASSISTANTS.

Names and titles
of assistants.

To carry on the work outlined, the following assistants have been appointed :—

G. HAMBACH, palæontologist.

G. E. LADD, assistant geologist in charge of Building Stones, Clays, Sands and Cements.

AMOS E. WOODWARD, assistant geologist in Mineralogy and Chemistry.

LEO GLUCK, assistant in the Coal Fields.

JAMES D. ROBERTSON, assistant in the Zinc and Lead Region.

ELSTON H. LONSDALE, aid.

GILMER MERIWETHER, aid. (Resigned February 10th.)

C. F. MARBUT, aid.

JOHN C. HALLIGAN, clerk.

Professor H. A. Wheeler, mining engineer, of St. Louis, has been engaged as a special assistant in connection with the study of the clays of the State. He will have special charge of the experimental work, and is working in conjunction with Mr. Ladd.

Special work on
the Clays.

In addition to this regular force of the State Survey, Mr. Walter P. Jenney has been detailed by the United States Geological Survey, to make an examination of the zinc and lead deposits of this and adjacent States. He is working in co-operation with the State Survey and the results reached by him will be published by the State. Further, the following persons are working in co-operation with the Survey as local and volunteer assistants:—

Zinc and Lead
Work of the U.
S. Survey.

JAMES A. MERRILL, assistant professor in natural sciences, State Normal School, Warrensburg.

Local and volun-
teer assistants.

E. M. SHEPARD, professor of natural sciences, Drury College, Springfield, Mo.

E. W. NEWTON, Bolivar, Polk Co., Mo.

During the coming summer it is probable that at least three additional volunteer assistants will be at work in the State, in various parts of it and on different subjects.

THE PROGRESS OF THE WORK.

Much of the time during the past six months has necessarily been spent upon work incidental to the organization of the Survey. Assistants had to be found and their credentials examined; office furniture, supplies and field instruments had to be provided. Forms for office records had to be prepared; details of field and office work had to be systematized and described, and assistants had to be instructed in them. A large amount of correspondence has also been carried on, in answer to applications and inquiries of all kinds. Arrangements have been made for an exchange of publications with various scientific bureaus and associations, and, as a result, the nucleus of a valuable reference library for the Survey has already been collected. The State geologist has given a large part of his time to these matters of organization, to editorial work and to ordinary administrative duties,

Operations to
date.

Exchanges and
Library.

such time as could be spared from these duties being spent in the field with the assistants, over all of whose work he is obliged to keep a general supervision, and over part of which he assumes immediate direction.

THE WORK ON THE ZINC AND LEAD DEPOSITS.

Corps engaged in
the work in the
Zinc and Lead
Regions.

Mr. Walter P. Jenney is in immediate charge of this work and with him is associated Mr. James D. Robertson. Mr. Jenney is the geologist of the United States Survey, assigned to this work here. Mr. Jenney's many years of experience in various mining districts of this country, added to a thorough scientific training, should admirably fit him for the study of the important subject which he is now in charge of. There is every reason to expect that immediate and valuable results will flow from his work, when it is made public. Mr. Robertson, a graduate of Washington University, is an assistant of the State Survey, detailed by the State geologist to assist Mr. Jenney. He was appointed an assistant and entered upon the discharge of his duties October 1st, 1889.

Operations to date
and ultimate re-
sults.

Mr. Jenney came to the State during the latter part of September. Early in October, he and Mr. Robertson started work in Jasper county and have since been busy examining mines in that and adjoining counties. They have also made brief studies in Greene, Christian, Lawrence and Polk counties, and also in Madison, St. Francois and other eastern counties. The objects of this inspection and study have been to obtain a clearer insight, than previous work has made possible, into the origin and mode of formation of the ore, and to acquire definite information as to its distribution. All of their work so far is, however, merely preliminary to the systematic and detailed investigation which these important deposits deserve, and for which it is the sincere hope of the State geologist that ample provisions will be made in the future, either by the national or State government.

THE WORK IN THE COAL FIELDS.

Corps engaged in
the work in the
Coal Fields.

This work is under the immediate direction of the State geologist. With him are associated Mr. Leo Gluck as assistant and

Mr. C. F. Marbut, who has succeeded Mr. Gilmer Meriwether, as aid. Mr. Gluck is a graduate of Washington University, St. Louis, and came to the Survey directly from Mine La Motte, where he was employed as chemist. He began work on October 23d, and after some three weeks of office work, started into the field about the middle of November. He has since been intermittently engaged in field and office work. Mr. Meriwether is a graduate of Vanderbilt University, Tennessee, and during the past year or two has been a resident of Kansas City, Missouri. He began work with the Survey on November 11th, and proceeded into the field with Mr. Gluck soon after. He resigned from the Survey early in February and his place was filled by Mr. C. F. Marbut, a graduate of the State University.

The regular work in the coal fields has thus far been confined to Lafayette county, but a large part of this county has already been covered, and a great amount of valuable material has been collected. It is the aim of the State geologist in this work to systematically collect such detailed facts as will enable him to illustrate and define, as closely as possible, by maps, sections and reports, the area underlain by individual coal beds, their probable depth beneath the surface at any point within such area, their probable thicknesses at such points, and the adaptabilities of the various kinds of coal. With these objects in view, every coal opening is visited, examined, and located on the map, every drill hole record is hunted up, copied for future use, and the position of the hole located on the map. Through this work every land owner will ultimately be placed in possession of the best attainable information concerning what underlies his land.

Operations to date
and ultimate re-
sults.

THE WORK ON THE BUILDING STONES, CLAYS, ETC.

Mr. G. E. Ladd, assistant geologist, is in immediate charge of the work. Mr. Elston H. Lonsdale, a graduate of the State University of Missouri, is his assistant. Mr. Ladd entered upon his duties here on December 1st, coming directly from Texas, where he was connected with the geological survey as an assistant geologist. Mr. Ladd is a graduate of Harvard College and

Corps engaged in
the work on the
Building Stones
and Clays.

has done geological work in the East, under Professor N. S. Shaler, for the United States Geological Survey.

The work on the clays of the State is to be a joint work, in which Professor H. A. Wheeler, of St. Louis, will be associated with Mr. Ladd; the former having especial charge of the experimental part of the investigations.

Operations to
date, and in the
future.

The past winter months have been spent by Mr. Ladd and Mr. Lonsdale in the field, in Iron, St. Francois and Madison counties. Their attention has been chiefly given to a preliminary examination of the building stones of that section. Mr. Ladd's report, in this bulletin, contains some of the results of this examination. Work has now been begun by Mr. Ladd and Professor Wheeler upon the important subject of the clays of the St. Louis district. Along with this, however, the detailed work in the southeastern counties still continues under Mr. Ladd's supervision and part of his time is spent there, while Mr. Lonsdale will be continuously occupied in the systematic mapping.

Importance of the
work on the
Building Stones
and Clays.

Very little available to the public has been done on the subjects of this division of the work, and, thus, very little is known about them. The work in progress has for its objects, first a description of the quarries, clay pits and other workings, accompanied by suitable maps and illustrations; second a determination of the areas underlain or covered by these materials, and thirdly a determination of their qualities. This latter is an important part of the work, but can not be taken up at once. It will include the determination of such questions as the resistance to compression, to attrition, to frost, to heat, to water etc., of the building stones, the readiness with which they are dressed or polished, etc. A thorough study of the clays gives promise of most fruitful results. The clay and dependent industries of the State are already of great magnitude. The demand for the products is not only increasing with the population, but new uses for the material are constantly being found. A determination of the distribution, the amount and the nature of the raw materials will result in benefits to both the land owner and the manufacturer.

THE WORK ON THE MINERAL WATERS.

An examination of the mineral waters of the State has been begun by Mr. A. E. Woodward, assistant geologist in charge of the mineralogical and chemical work of the Survey. Mr. Woodward was recently assistant in geology at the Massachusetts Institute of Technology. He was appointed to his position on the Survey in December last, and reported for work early in January. During the past months he has made examinations in the field and has collected samples for analysis of the mineral waters of Saline county. Since this time he has superintended the outfitting of the laboratory of the Survey, has made analyses of the mineral waters and of other samples, and has attended to miscellaneous duties connected with the collections of the Survey.

Assistant engaged
in the work on
the Mineral
Waters.

Operations to
date.

THE WORK OF THE PALÆONTOLOGIST.

Dr. G. Hambach, adjunct professor of geology at Washington University, St. Louis, has been appointed palæontologist. He assumed the duties of his position October 20th. He gives to work of the Survey only part of his time. During the past six months, in addition to preparing the list of fossils published in this bulletin, he has been occupied in examining and preparing for study a large amount of palæontological material which has been inherited from previous surveys of the State. He has also made several trips to examine collections already made by the Survey. His paper in this bulletin, prepared at the suggestion of the State geologist, is a valuable statement of the condition of our knowledge of the palæontology of the State and will be of great use to all field geologists.

The palæontol-
ogist.

Operations to
date.

THE WORK OF VOLUNTEER AND LOCAL ASSISTANTS.

Professor J. A. Merrill, of Warrensburg, has volunteered his services to the Survey. The subject of his work, for the present, will be the geology of Johnson county, especially that part in the vicinity of Warrensburg. Professor Shepard, of Springfield, and Major Newton, of Bolivar, have already made a con-

Persons acting as
volunteer and
local assistants.

siderable study of the geology of their respective counties, and have their notes recorded in an available form. This material is placed at the disposal of the Survey and additions will be made through future field work. The work of these gentlemen will be only such as they can find time for, outside of their regular occupations. At present this amounts to only an occasional day, but, during the summer, several months' time will probably be given. Their work will be of great assistance to the Survey as supplementary to the systematic work in the various counties.

Work in Jackson
County.

Mr. Edwin Walters, of Kansas City, was in the employ of the Survey, as a temporary assistant, during the month of November. He was engaged in collecting drill hole data and other facts relating to the geology of Jackson county.

THE WORK OF THE UNITED STATES GEOLOGICAL SURVEY.

Work of the U. S.
Geological Sur-
vey previous to
1889.

Previous to the year 1889 the United States Geological Survey had confined its operations in this State almost entirely to topographic work. As a result of this there is now about one-half of the area of the State mapped, on a scale of about 2 miles to the inch and with a contour interval of 50 feet. Further, Mr. W. J. McGee, United States geologist, made in 1887 a special survey of a portion of Macon county.

Work contem-
plated in the im-
mediate future.

The State geologist has now the assurance of the Director of the United States Geological Survey that the topographic work will be resumed here this year. In addition a special assistant will be sent here this Spring to work on the palæontology of the State, under the direction of the State geologist, and with the advice of Professor H. S. Williams, of Cornell, who will report upon the collections.

The continuance
of the work in
the Zinc and
Lead Regions.

The continuance of the work on the zinc and lead deposits, by the National Survey, is provided for up to the end of June, 1890. In what manner it will be continued after that date is not decided. It is to be hoped, however, that this will be with much more ample means and on a scale proportional to the importance of the subject.

THE WORK OF THE UNITED STATES COAST AND GEODETIC SURVEY.

Up to the present date the United States Coast and Geodetic Survey has carried a chain of primary triangles from the Mississippi river across the State to Kansas City, and has further run a line of precise levels up the Missouri river valley as far as Jefferson City. These levels are of value in the prosecution of geologic work, are indispensable for the construction of correct topographic maps, and will be valuable in the future for engineering projects of all kinds. It is desirable that the line to Jefferson City be extended up the Missouri valley to Kansas City, and thence southwards to the Arkansas line and the probability is that the work will be done this year.

Work of the U. S. Coast and Geodetic Survey to date.

FUTURE PROGRESS AND ULTIMATE RESULT OF THE SURVEY.

The ultimate result to be obtained by the geological survey of the State is a complete knowledge of its natural features and products. The work will not be one of startling discoveries, but rather of simple descriptions based upon facts patiently accumulated. The object will not be to bring disproportionately into prominence any one mining enterprise or district; but rather to give, in a nearly uniform manner, an exact description of every subject or area studied. Such descriptions are sought after by the property owner, by the miner, by the investor, by the home-seeker and by the professional man. They should be accessible to all in such a form as to be plainly intelligible, and in such detail as to be of immediate use in practice. The information which the maps and reports will contain will be, in part, such as the native of long residence may be familiar with, but which is news and information of value to the stranger; and it will be, in part, such as the resident property owner is probably not familiar with and concerning which he may have only the wildest hypothesis to guide him. These two classes of facts grade into each other, of course, insensibly, and they are both, properly, parts of a complete description.

The nature of the work of the State Geological Survey.

Simple and exact descriptions. The objects.

The material for such description must be collected systematically and patiently on the ground, and too rapid progress must not be expected. Too much must not be expected in a short

Final results cannot be attained quickly.

time, nor must work be looked for in too many places at the same time. The Survey force is small and the area to be covered is great. Good work demands time.

Partial and provisional results to be published in bulletin articles.

But, though detailed and accurate work is necessary for results of permanent value, so much time has elapsed since any description of the geology of the State or of its mineral industries has been made, that no recent and reliable information concerning these subjects is to be had. To supply this want, it is the intention of the Survey to push forward, as rapidly as possible, a reconnaissance along the various lines of study which are taken up, at the same time that the detailed work is in progress in special localities. The results of this reconnaissance work will be published in bulletin articles, such as are herewith presented, while the results of the detailed work will make up the matter of the monographs and of a series of uniform, detailed maps.

PUBLICATIONS OF THE SURVEY.

The nature of the bulletins.

The results of Survey work will be published in bulletins and in monographs or systematic reports upon special subjects or areas. The bulletins will be issued as nearly periodically as possible, probably every three months, and it is the object to publish in them short papers which are complete in themselves, and such partial results as admit of, or demand immediate publication. A part of the value of some results lies largely in their being made immediately known, and these bulletins furnish thus a convenient means for making such information public.

The nature of the monograph.

The monograph will be the result of comprehensive and exhaustive study; in it will be collected all that is known of the subject or area under consideration; it will be subdivided into topics and these will be systematically discussed; it will be illustrated by maps, diagrams and plates, and will be a volume of permanent value for reference. Disconnected material already published in bulletins, may reappear in a more complete form in a monograph as parts of a systematic discussion of topics.

CABINET, COLLECTIONS AND LIBRARY OF THE SURVEY.

A collection for a State Cabinet is begun.

The act creating the Survey makes special reference to collections and the formation of a State Cabinet by the Survey.

With this object in view a part of one of the rooms occupied by the Survey in the Capitol building has been fitted with specimen cases and shelves. A collection to be put in these cases is already started, and it is thought that, by next Autumn, enough material will be on hand to make the beginning of an instructive exhibit.

The value of such an exhibit, when carefully arranged with a view to illustrating definite occurrences or processes, and when accompanied by all necessary charts and diagrams, can hardly be overestimated. But to make such a collection valuable it *must be carefully arranged*. The specimens must be nicely prepared, must be plainly labeled and must be assorted and grouped with patient thought and study. There should be no restriction in space. Such a collection, when prepared, represents a great outlay of time and money. When once prepared its perpetuation and healthy growth should be assured for all time. The collections made by previous surveys of the State are now either scattered and largely lost to public use, or are buried in boxes and cases, dust covered and without labels, of little more value than so much rock from a dump pile. Every State should have, located at its center of industry and intellectual activity, a well equipped museum, under active management and responsive to the needs of the times. There, should be exhibited and explained the natural features and the products of the State, and there, should be systematically collected, recorded and preserved from injury and loss, all that mass of facts which constitutes the basis of complete knowledge.

The value of a State Museum.

The Museum should be permanent.

RELATIONS OF THE SURVEY TO LOCAL AND PRIVATE WORK.

The State geologist receives many applications to visit and to examine different localities in the interests of individuals or of certain sections. Inasmuch as the Survey force is small, and as the whole force is engaged in prosecuting the work systematically in the study of specified districts or subjects, it is impossible to meet these applications in the manner anticipated. A mere inspection by the State geologist, or an assistant, in answer to such application, would, in most cases, serve no useful purpose. An area must be studied systematically and in detail for conclusions of value to be reached. The State geologist is, however,

Reasons why it is impracticable to visit localities on application.

glad to receive, from any part of the State, notice of discoveries and records and information of all kinds. Especially is it desirable that copies of records of all deep drill holes be sent him. Such communications will be held as confidential if desired. With the light of all the facts accumulated by the Survey, the geologist may be able to draw conclusions from such records which the driller might be far from suspecting. Further, the Survey office is the best possible place for recording such results. They are attained at too great a cost to be allowed to go to waste. The facts ascertained by such drilling are of value for all future. Even if only of negative value, a carefully kept record will often prevent repetition of useless work; while, on the other hand, results which, at the time, may have no economic value, may, with later developments, have most important bearings. When such drilling is in prospect, the State geologist, if advised, will be glad to give suggestions as to the proper method of sampling and preserving record of the drillings of such holes.

Drill Hole records
desired.

Information sent
should be
definite.

It is particularly important that all information sent should be as definite as possible and that the exact location of any occurrence of interest be given by township, range, section, quarter section and fraction. Such information will then be duly recorded and filed, and when the survey reaches that section, in the progress of its regular work, the locality will be examined and reported upon with all due care.

Directions for
sending specimens.

With regard to specimens sent to the State geologist the following rules should be observed:—

1. Packages should be addressed to the State geologist, Jefferson City, Mo.

2. Specimens sent, whether by mail or express, should be fully prepaid.

3. The name and address of the sender should accompany the package, and the township, range, section, and quarter from which it comes should be given. If the matter is of importance, it will be regarded as confidential, if desired.

Much of the material sent in is, upon its face, valueless, while in other cases there is doubt which can only be determined by chemical examination. In cases where no critical examination is required, the State geologist will give his opinion regarding

Limits of examination.

the specimens, and, where an assay or analysis is necessary, he will, if desired, make suggestions as to the advisability of having assays or analyses made.

It should be borne in mind, however, that the State Survey is not at liberty to make these assays or analyses gratuitously or for a consideration. Inasmuch as many persons fail to understand why the Survey cannot do such work, some of the reasons are here given.

Assays and Analyses not made;—
reasons why.

First. The Survey cannot know where the specimens come from that are sent in by others than its own members, and can therefore never draw trustworthy conclusions from them.

Second. In many cases material is sent in of which it would be a waste of time to make a detailed examination, and in other cases alloys and artificial products are sent which would require more time than the cases warrant.

Third. If the Survey were at liberty to do private work, it would be possible for a single individual or company to take up the entire time of the chemist in doing his or its private work to the exclusion of all others. A person having interest outside of the State might hand in an immense amount of material for examination, and the State of Missouri would thus be conducting a chemical laboratory for his exclusive benefit.

Fourth. The chemical work absolutely essential to the successful operation of the Survey, occupies the full time of the chemist.

NOTES ON THE COAL BEDS OF LAFAYETTE COUNTY.

BY ARTHUR WINSLOW, State geologist.

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Previous geologic
work in Lafay-
ette county.

The geology of Lafayette county has not been connectedly studied nor described even to the extent that other counties of the State have received treatment by the earlier geological surveys. About all that has been published is contained in the report of the Geology of Northwestern Missouri by G. C. Broadhead, in Part II. of the Report on Iron Ores and Coal Fields of 1872; some fourteen pages, in the first part of this report, refer to the geology of Lafayette county, and matter relating to it is also found in a dozen or more other pages, scattered through the report. The information thus given is, further, neither connected nor complete, but consists largely of descriptions of outcrops, sections and records found at various localities and de-

Scope of present
work.

rived from various sources. The systematic work which is now in progress in the county aims to give an exhaustive description of its geology in a report illustrated by detailed maps and sections. The progress of such work is, however, necessarily slow and, pending its completion and pursuant to the general plan of work described in the preceding administrative report, this brief

A SKETCH MAP OF

LAFAYETTE COUNTY

SHOWING THE APPROXIMATE

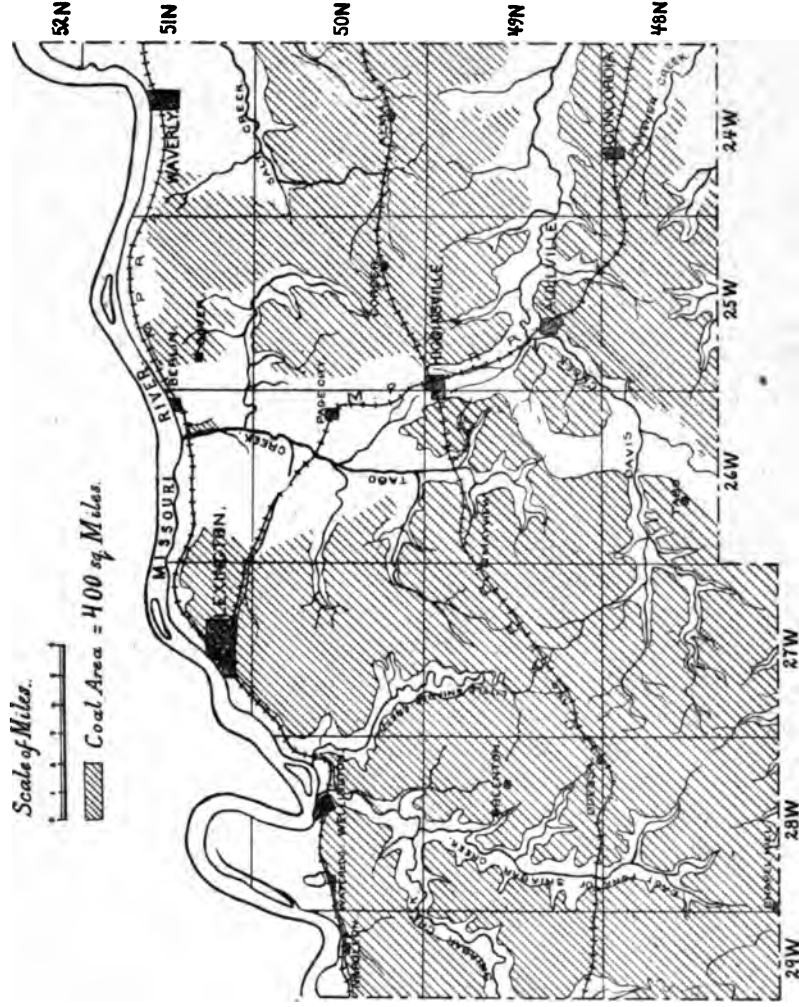
COAL AREA

INCLUDED WITHIN
THE LIMITS OF THE

MULKY AND LEXINGTON BEDS

AS PROVISIONALLY
OUTLINED.

ATYPICAL SECTION OF
THE LEXINGTON COAL BED
AND ASSOCIATED ROCKS.



article is prepared, relating to what is at present the most important mineral product of the county.

Results here expressed are provisional.

It is to be distinctly understood, however, that the conclusions here expressed are not final, and are subject to the modifications which the results of detailed work may hereafter call for. The descriptions and the deductions are almost entirely such as result from a reconnaissance and are presented, merely, to answer immediate calls for information, while the detailed work is in progress.

Rocks belong to the Middle Coal Measures.

The Rocks of Lafayette County, with the exception of a few patches in the western portion, have been referred, by the geologists of the earlier surveys, to the Middle Coal Measures. They consist of alternations of limestones, shales, sandstones, clays and coal beds, the whole aggregating several hundred feet in thickness.

The Coal Beds of Lafayette county.

In this column of rocks several coal beds occur. Of these, what is known as the Lexington Coal Bed is at present of greatest industrial importance. In the southeastern portion of the county, however, in the vicinity of Concordia and Aullville, another underlying bed, known as the Mulky coal, is worked and is there of chief importance. Outcroppings of other beds occur at numerous localities where the coal is too thin to be profitably worked; at some places, notably above Waverly, such coal is reported to have been dug into of considerable thickness, but the developments are not sufficient for one to predict the extent of the bed. Again, at other localities, deep drill holes have been put down in which thick coal beds are reported to have been struck; but the results from such deep drillings at different places are conflicting, and it will take a closer study than this article purports to be the result of, a more careful sifting of facts, before the reported results of such drillings can be reliably judged of.

Position of the Lexington Coal Bed.

The Lexington Coal Bed is situated geologically in the neighborhood of 230 feet below the top of the Middle Coal Measures. Geographically it is included within the shaded area of the page plate map accompanying this article, and west of Aullville the outlines of this shaded area represent approximately the outcrop line of this bed, as provisionally defined. East of Aullville it rises

higher above water level and is found only near the hill tops in comparatively limited patches. Hypsometrically it is in such a position that its outcrop is almost always above the adjacent water level. It lies in a gently undulating sheet, with a slight north westerly dip, which crops out along a sinuous line on each side of the main drainage channels. The thickness of this bed is not very variable, and a fair average of its sections is shown in the plat on the accompanying plate. In the vicinity of Lexington it exceeds the average by two or three inches and in a few localities reaches a thickness of two feet. West of Lexington, along the river about Wellington and Napoleon, the coal is about eighteen inches thick; in the vicinity of Higginsville and Corder it is from seventeen to twenty inches thick, and in the vicinity of Odessa it is from fifteen to sixteen inches thick.

Thickness of the
Lexington Coal
Bed.

The Mulky Coal Bed is situated, as far as we can judge from present knowledge, at a very variable distance below the Lexington bed. In the vicinity of Mulky creek, two and a half miles southeast of Aullville, the interval between the two beds is in the neighborhood of fifty feet. About a mile southeast of this point, it is apparently nearer seventy feet; while, in the vicinity of Aullville, concordant results of two drill holes show the existence of a bed below the Lexington coal at a depth of about one hundred and fifty feet, which coal, is the only one in this section which could be considered the equivalent of the Mulky bed.

The position of
the Mulky Coal
Bed.

The existence and the distribution of the Mulky coal is best determined in the vicinity of Aullville and the outline of the shaded area east and northeast of that place approximately defines its limits, as far as has been determined by reconnoissance. West of this, drill hole records or other results of deep explorations are too scarce, and the country has not, as yet, been sufficiently studied for one to attempt to define the distribution of this coal, or even to assert its existence or absence over this area. The thickness of the Mulky bed, where opened upon, is seen to be very nearly the same as that of the Lexington bed. At three different openings, a few miles west of Concordia, the thicknesses measured were respectively: nineteen inches, twenty-two inches, and twenty inches; at the Elling shaft, nearly four miles west of Concordia, the thickness is reported to be between twenty-two and twenty-four inches.

The distribution
of this bed un-
certain.

Thickness of the
Mulky coal.

Breaks in the continuity of the Coal area due to two causes.

The sandstone belt.

Age of the sandstone.

The Coal Area. A study of the accompanying map will show that the continuity of the coal area is very much broken.* This is due to two causes. One is a cause at present in action and, though extending back far into geologic time, is yet posterior to the deposition of all the Carboniferous rocks in the county; namely, the process of erosion along the lines of flow of the now existing streams. But, in addition to what may thus be called the erosion area of these streams, a sinuous strip of country, destitute of coal, can be traced on the map from the south line of the county, near Tabo post-office, northwards through Higginsville and Page City to the river. In this strip, which in the vicinity of Higginsville is between one and two miles broad, no Lexington coal bed is found. On the contrary, deep drill holes have been put down hundreds of feet into the ground here and have struck nothing but sandstone and shales. It is in this strip that the McCauslan farm drill hole, reported to be eight hundred feet deep, is located, which is referred to on page 42 of Part II of the report of 1872. This sandstone is considered in the report of 1872, above referred to, to be the upper sandstone of the Lower Coal Measures, and its position has been explained by considering it a protuberance of these lower rocks. Recent drillings and other developments, however, furnish reasons for a modification of this view, and the writer is inclined to assign a *later* age to these sandstones than to the adjacent coals and limestones. The strip above outlined has all the appearances of being the site of an ancient river channel, eroded during some brief period of elevation and afterwards filled by deposits of sand and finer material, during a subsequent period of submergence. Studies now in progress in Johnson county, in the extension of this line, go to confirm this interpretation, but sufficient facts have not yet been accumulated for it to have been accepted as final, nor for the age of such erosion to have been determined. It is presented merely as a promising working hypothesis, and criticism of it will be very welcome.

*The limits of this coal area, it will be noticed, are not marked in places by definite lines. This, in some cases, is because data have not been obtainable for accurate definition, while elsewhere, especially in the eastern and north-eastern portion of the county, the work of the Survey has not yet progressed far enough for closer delineation to be attempted.

The Coal Tonnage. The total coal area of Lafayette county, The Coal Area of Lafayette county. as shown on the map, is approximately four hundred square miles. From this figure an approximate estimate can be made of the coal tonnage of the county. For this purpose we will neglect those areas of the Lexington coal which are known to overlie the Mulky coal east of Aullville, and will throw out of the consideration any portion of the Mulky coal bed which may underlie the area west of Aullville. Thus the estimate will be on the assumption of only one coal bed over the entire coal area. Should the presence of the Mulky bed west of the vicinity of Aullville be demonstrated later, a very great increment to this estimate of the coal tonnage of the county will be made. For the purposes of this estimate, we will further assume eighteen inches as an average thickness of the coal over this area. On this basis, the total amount of coal in the county would be 669,-
Total amount of coal.
 000,000 tons or about 2,600 tons per acre. With the present methods of mining it is probable that nearly 80 per cent. of the coal in the ground is excavated and shipped; but assuming it to be even as low as 60 per cent., the gross value of the product from the above total tonnage, at present market prices, would be about \$670,000,000. Allowing a net profit of twenty-five
Total value of the coal.
 cents per ton (about one cent per bushel), the total net profit on this amount of coal would be in the neighborhood of \$100,-000,000. On the same assumption, the gross value per acre of the contained coal would be in the neighborhood of \$2,500, while the net value would be about \$400.00 per acre.

The value of the coal contents of such land, based upon the present market prices of the same substance, is thus many times
Difficulties in the way of fixing exact values.
 what the land is valued at for farming purposes. Coal, however, is a possession which is not convertible until excavated and transported to market, and, until this is done, it represents just so much capital lying idle in the ground. Moreover, the coal of any one tract cannot be opened upon, excavated and thus converted into ready money in a short time; but the work will proceed slowly and the returns will come in gradually from year to year. Thus, if a man own a property of forty acres, of which, according to our calculation, the net value of the coal is \$16,000, and if he does not receive any of this \$16,000 until the expira-

tion of fifteen years, then the present value of his land is a sum, which, at compound interest at current rates, will amount to \$16,000 in fifteen years; this at 6 per cent. interest will be about \$6,700. The exact time when a man may receive the full net value of the coal contents of his land depends upon many indefinite factors, such as the growth of facilities of transportation, the demand for the product, etc. It is thus impossible to give any one value per acre which will apply to all coal lands, even though their coal contents and the conditions under which it occurs be similar.

Prospects of the
Coal Industry.

The Coal Industry. For Lafayette county, however, there is every prospect that the coal industry will increase largely in the near future, and the developments will probably be most active along and adjacent to the railway lines at present constructed. This county stands already second in the State in the amount of its annual production, and the product for the year ending June 30th, 1889, was over 320,000 tons, with an average value at the mine of nearly \$537,000. This product is about 14 per cent. of the total for the State during the same period.

The extensive
working of so
thin a bed is re-
markable.

The fact that, in this county, a coal bed is worked, on a large commercial scale, and at considerable profit, which, at the most, is very little over two feet in thickness, and which is generally considerably less than this, will be to many a surprising fact. In this country coal less than two feet in thickness has been ignored in tonnage estimates, and when less than three feet in thickness has been considered of value only when above water level and otherwise favorably located for cheap mining. In the present case, not only is the bed less than two feet in thickness, but it is mined in places by shafts nearly one hundred feet deep, out of which all water has to be pumped. In England coal seams less than two feet in thickness are considered workable on large scales, and official estimates of the workable coal of the United Kingdom have included all beds above one foot thick, within a depth of 4,000 feet. That this country will, before many years, approach England in industrial activity cannot be doubted. The practicability of working these coal beds of Lafayette county under present conditions is a demonstrated fact; with further in-

Limits assigned in
England.

dustrial growth we can, therefore, confidently look forward to a much greater development of its coal interests.

The reasons which have permitted the mining of this coal so far will apply equally to its development in the future. Briefly stated these are, first that it is generally above water level and can be opened by drifts or shallow shafts, can be drained by natural flow or with siphons. This condition of the bed is well seen along the river bluffs where the coal crops out, generally above the level of the railway, continuously for miles. Towards the interior, the general northwesterly dip of the bed, and consequent southerly rise, tends to maintain this relation between the position of the beds and the traversing drainage channels, so that the coal crops out at frequent intervals along the hill sides bordering the streams. Further, among the conditions favoring the mining of this coal, is the presence of an excellent roof which overlies it, and the fact that the proportions and divisions of slate, between the coal and the limestone head rock, are such as to permit of mining by a method similar to the long-wall, by which almost all of the coal is excavated. With future developments and enlargements of the industry, it is probable that coal will be produced at a considerably lower cost than at present. Mining is still carried on here, on what would be considered elsewhere a small scale; cutting of the coal is done by hand and hauling in the mines either by man or mule power. With the introduction of suitable coal cutters and wire rope haulage the cost of production will be considerably reduced.

Conditions favor-
ing mining in
Lafayette coun-
ty.

Enlargement of
works will
cheapen cost.

The Composition of the Coal. No analyses or other tests of these coals of this county have been made by this Survey. In Part I of the Report of 1872, already cited, analyses of six of these coals are given which show the following ranges of composition: —

Analyses of the
coal.

Water.....	5.55 to 8.85 per cent.
Volatile matter.....	34.05 “ 42.95 “ “
Fixed carbon.....	39.66 “ 50.04 “ “
Ash.....	5.14 “ 18.17 “ “

They are, thus, decidedly bituminous coals, somewhat high in water and in ash. Just what their capabilities are for the purpose of coking, gas production, or any other of the uses to which coal is put, cannot be stated without further examination.

NOTES ON THE
BUILDING STONES, CLAYS AND SANDS OF IRON,
ST. FRANCOIS AND MADISON COUNTIES, MIS-
SOURI.*

By G. E. LADD, assistant geologist.

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* These notes relate to an area where detailed work is in progress upon the various geological problems presented. Chemical and physical tests, and microscopic studies of the specimens selected in the field, are necessarily reserved for the future, and this paper is, therefore, chiefly descriptive of localities, and contains only such results and generalizations as a brief field inspection will warrant.

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PREFATORY REMARKS.

The following paper, on the building materials of three of the southeastern counties of the State, is the product of about two months' time spent in the field; and though, by no means exhaustive, it will be found a useful description of an, as yet, almost untouched subject, and its preparation reflects great credit upon the energies and discernment of its author. This article, like others of the bulletin, is a partial result; it is a provisional publication and may be taken as a sample of what will be produced in the future from that general reconnoissance along the various lines of work, to be carried on simultaneously with the systematic and detailed work, as outlined in the preceding administrative report. The questions relating to the origin, distribution and properties of the substances here treated of, are numerous and intricate, and can only be solved by critical and comprehensive study. But the importance of these questions demands just such study as this. The very incomplete figures which the Survey has so far been able to collect are yet sufficient to show that the value of the total product of stone quarries of the State reaches many millions of dollars, and the value of the annual product must be now several millions. Stone is destined to be used more and more in the future for building and other purposes, and this not merely in the ratio of the increase of population, but further because permanent construction is destined to succeed the temporary construction which has been largely the practice heretofore. This change is already taking place in the East, and, as a notable illustration, may be cited the case of the Pennsylvania Railway, where iron bridges and other structures are being almost entirely replaced by stone ones. Though no definite figures relating to the clay products are at hand, their value cannot be second to those of the stone quarries, and the tile and brick industry of the State is recognized to be among the most important in the country. Its future growth cannot be doubted. With the recognized importance of these substances in the industrial world, the

time is certainly past when we should be comparatively in the dark, not only as to their distribution and as to the best localities for obtaining them, but also as to their capabilities and adaptabilities, when found. Enterprises must fail if they have not this fore-knowledge. Scientific experimentation should always precede an industrial venture, and this experimentation should be exhaustive and on a scale proportional to the interests involved. The increase in the number of laboratories and testing works during recent years is an indication that this need is beginning to be felt, and it is with an appreciation of this need that the Survey contemplates, as part of its work, an investigation into the properties of the materials herein treated of.

ARTHUR WINSLOW, State geologist.

GENERAL GEOLOGY.

Presumable age of
the rocks.

Iron, St. Francois and Madison counties, situated in Southeastern Missouri, include the most important part of what is known as the Missouri Archæan district. With the recognized Archæan rocks, however, Lower Silurian rocks are associated; • the Archæan rocks rising in hills of dome-like shape through the Lower Silurian strata, which surround and rest upon them. The hills vary in height from less than one hundred feet to about seven hundred feet. The rocks which have been determined as composing the Archæan, are the crystalline siliceous rocks and the porphyry conglomerates, given in the following classification. The Lower Silurian strata consist of what is possibly Potsdam Sandstone, and of the Second Sandstone and of the Third Magnesian Limestone of Swallow. The latter formation consists of thick beds of limestone, which are often magnesian, and also of beds of marble; the latter are, however, of much more limited distribution than the former.

Nature of the
rocks.

Classification of
the rocks.

For convenience of discussion the following provisional classification of the rocks of this region is adopted. It is a classification adopted with reference to the industrial uses of the rocks. It cannot be considered in any way final until a detailed study into the origin and composition of the various rocks is made.

1. CRYSTALLINE SILICEOUS ROCKS.

- a. Granite.
- b. Syenite.

- c. Porphyry and Felsite.
- d. Diabase and Diorite.
- 2. CARBONATES.
 - a. Limestone.
 - b. Marble.
- 3. FRAGMENTAL ROCKS.
 - a. Sandstone.
 - b. Conglomerates and Breccias.

The clays of commercial value, so far as discovered, are not wide-spread, and are practically undeveloped. The clays which have been worked are classed locally as brick and pottery clays, and will be discussed under these headings. The sands and gravels are recent Quarternary deposits.

Clays and sands.

BUILDING STONES.

The building stones are the most important materials of construction to be considered here; they will be discussed in the order of the classification given.

CRYSTALLINE SILICEOUS ROCKS.

Granites. — Of this group the granites afford the most valuable structural materials. Their most important occurrences are in the southern part of St. Francois county, the northeastern part of Iron and the northwestern part of Madison counties. These rocks have many qualities to recommend them, which are apparent on cursory observation. The colors are excellent, varying from red and pink to gray, while often a contrast between the colors of the constituent minerals yields very beautiful effects. They take a brilliant polish, are very strong and are reasonably durable. Other considerations which make these granites valuable lie in the conditions under which they occur, and these conditions probably hold over extensive areas. The first of these is, that the joint planes, or open seams in the rock, are in number and arrangement so happily adjusted as to make the quarrying of the rock easy and economical. The second, is that very little "stripping" has to be removed before stone quarrying may be carried on. Further, the stones are easily split by the quarryman, and are easily dressed by the stone cutter.

Distribution of the granites.

Qualities.

Conditions of occurrence.

The localities where the granite is workable, although not immediately accessible to the railway, can be reached in most cases by switches or tramways. The demand for these granites for building purposes and for paving blocks seems to be constantly growing. The principal markets are St. Louis and Chicago, but the stone has found its way to many distant parts of the United States.

Demand and market for granites.

Distribution and qualities of the syenites.

Uses.

"Motions" and "motion work."

Distribution and qualities of the porphyries and felsites.

Syenites. The syenites are wide-spread, but have been quarried only in St. Francois county. They take a good polish and are very handsome. Their colors are dark pink, and light and dark grays, which are mottled with red feldspars and with black crystals of hornblende. These rocks, when quarried, are now used entirely for paving purposes. Only one attempt has been made to quarry them for dimension stone, and this proved a failure because of the easy fracturing of the rocks along numerous, almost imperceptible seams.

Near Knob Lick the syenite is worked extensively in "motions," the name motion being given in this region to a class of work confined to boulders, which either lie already loose upon the surface, or are excavated from the decayed rock by pick and shovel. These boulders in the syenite lie *in situ* to a depth of twenty or more feet. The decay of the rock mass has progressed from a net work of joint planes, the amount of decay diminishing away from these planes until, near the center of the meshes, the boulders are still fresh and ready to be split and worked. Many are thus able to make paving blocks who could not assume the expense of opening a quarry. A "motion" man, assisted by a boy to drill and split boulders, will probably produce from this rock an average of seventy paving blocks a day. Motions are occasionally developed until bed-rock is reached, when derricks are put in use and small quarries opened.

Porphyries and Felsites. The porphyries and felsites are widely distributed and make up the greater part of the Archæan rocks. They take a high polish, and are of widely varying colors, such as red, purple, green, black and brown of many shades. The porphyries are especially handsome, containing, as they do, crystals varying from mere specks to those several inches long, which contrast beautifully in color with the matrix of the rock

They are exceedingly hard and break with a sub-concoidal fracture. Their specific gravity is very high. For dimension work these rocks will probably never be extensively quarried, principally because the joint planes which intersect them are so numerous as to make it impossible, or at least extremely difficult, to obtain large enough blocks; and also because the rock is so very hard that, worked by present methods, it cannot be dressed without too great an expense. However, they split easily and are widely worked by small companies for paving blocks; and for these they have the recommendation of being very durable, but have the defect that, unlike the granites which wear to a very rough surface, they become very smooth and slippery with use. Uses limited.

Diabases and Diorites. These rocks are found most extensively in Madison county. They are commonly called green stones, and are intrusive in the granites, but have not been observed in the porphyries by the writer. They are mostly dark gray in color, and are as readily polished and dressed as the granites. Such attempts as have been made to quarry them for dimension stone have failed completely on account of the large number of seams and joint planes. They make good paving stone and are easily quarried and split. Distribution of diabases and diorites. Qualities.

CARBONATES.

Limestones. The limestones exist in these counties in inexhaustible supplies. They are, as a rule, easily quarried, and some of them dress very readily. Their best color is a soft buff, although they are also of a dark gray and an almost white color. They seem to be very durable. No attempt has been made to quarry them for any commercial purposes. Locally they are used extensively for foundations, bridges, walls, tiling, etc., and a few very handsome dwelling houses have been constructed of them. Distribution and qualities of limestones. Uses.

Marbles. The marbles are confined in these counties, so far as is known, to Iron and Madison counties. In Iron county their distribution is confined to the territory drained by Marble creek and the head waters of Stout's creek. In Madison county they are confined practically to the townships of ranges five and six east, Distribution of marbles.

Mode of occurrence.	and, in these, to the territory south of the Little St. Francois river.
Qualities.	The marbles occur, in places, with a total thickness of probably thirty or more feet, and some strata may be found which are two feet or more thick. Their colors are beautiful, varying from light gray to dark red and chocolate, sometimes exquisitely combined in variegation. They are capable of taking a brilliant
The development of the marbles.	polish. No well directed effort has been made to develop these marbles, but several partially successful efforts have been made. The chief reasons for their discontinuance have been: the distance from railways, thinness of strata, frequent seams and blotches of green and brown ferruginous clays which weather out on exposure, and a tendency of the stone to "pluck," in a damaging way, under the tools of the stone cutter. In spite of these numerous drawbacks there are, however, many places where well conducted quarrying may be profitably carried on, and the marbles made a source of considerable wealth.

FRAGMENTAL ROCKS.

Distribution of the sandstones.	<i>Sandstone.</i> The Second Sandstone is found in many localities capping the Magnesian Limestones or resting upon the Archæan rocks. In St. Francois and Madison counties the beds sometimes reach a thickness of one hundred feet or more.
Qualities.	They are often saccharoidal, but are mostly stained red or yellow with ferric oxide. They disintegrate most easily and are unfit for building material, although they have been used by the railway company in constructing bridge abutments, and locally for door and window sills.
Distribution of conglomerates.	<i>Conglomerates and Breccias.</i> Several varieties of these rocks are found, most of which are not now in their proper geological horizon, but exist only as boulders scattered over the hill slopes. The contained pebbles are usually limestone, while the cementing material varies, being in different localities, lime, silica and limonite respectively. On Pilot knob and Shepherd mountain, Iron county, there occurs a porphyry conglomerate in which the
Porphyry conglomerate.	pebbles (often large enough to be called boulders) are porphyry, as is also the cementing matrix. This rock was quarried locally at Ironton, but was found to be not durable, disintegrating very rapidly. Extensive and thick beds of porphyry conglomerate

are found in the northwestern part of Madison county and in the eastern part of Iron county. In the western part of Iron county is a conglomerate consisting of light green crystalline limestone, or marble, containing small, well rounded pebbles of a darker green sub-crystalline limestone. It makes a very handsome ornamental stone, but the quantity is probably so limited as to make the occurrence of no commercial value.

CLAYS.

In the area here discussed no sedimentary clays have been observed excepting such as have resulted from local washings from the hillsides; but, of residual clays, there are very extensive beds, products from local decomposition of the rocks, which vary in thickness from a few inches to seventy feet or more.*

BRICK CLAYS.

The only demand for bricks is the local one, which is extremely small; consequently the industry has been carried on only in a desultory way. The material used is a clay, residuary from magnesian limestone, but is fit for use only to a depth of about eighteen inches, where, having been weathered and leached by rain water, it is in a condition to make a fair quality of brick which burn to very dark colors. The clay is sticky and much sand is required in moulding it, which is probably the reason for the failure of several brick making machines which have been tried in Iron and Madison counties.

In Iron county, brick has been made at Ironton, Iron Mountain, Middlebrook and Arcadia. The total product amounts probably to not over 6,000,000 bricks.

In St. Francois county, bricks have been made at Farmington, Bonne Terre, Doe Run and DeLassus. The product to date amounts to about 15,000,000 bricks.

In Madison county, bricks have been made at Fredericktown and at many small kilns in the country. The total product is probably less than 30,000,000 bricks.

* See Geological Survey, Missouri, 1872, page 13. Raphael Pumpelly.

POTTERY CLAYS.

Distribution of
kaolins.

Kaolins are known to exist at several localities. These are in the western part of Iron county, and in the eastern part of Madison county. The clays result from the decomposition, *in situ*, of certain porphyry rocks, and they have probably a wider distribution than that at present observed.

Origin.

Uses.

In both Madison and Iron counties, many years ago, these kaolins were mined, and made into several excellent varieties of stone ware. The discontinuance of these works appears to have been due not in any way to the character of the clay, but rather to lack of cheap transportation facilities, and, possibly, to private reasons of the owners.

Examinations not
yet completed.

The writer has not yet had opportunity to properly examine any of these kaolins, because such pits as have been opened into them have become filled with water and debris during a long period of disuse, and the samples taken from the dumps about the pits are not now worthy of analysis or mechanical test. The facts observed by a cursory examination indicate, however, that there are extensive occurrences of a valuable quality of kaolin which is adapted for the production of a high grade of stone ware. In some places it contains a large per cent. of peroxide of iron, and will make a valuable commercial paint. It is the intention of the Survey to make further and more detailed examinations into the extent and character of these clays.

SANDS.

Stream sands.

The many water-courses furnish an abundance of sand and gravels of chert and porphyry. These are easily accessible and are extremely useful as road-making materials. A sandstone which has been assigned to the same geological horizon as that at Crystal City, occurs in some localities, and is soft and saccharoidal and otherwise similar to this stone. Chemical examinations have not yet been made of it.

Sand-rock.

DESCRIPTIVE LIST OF STONE QUARRIES.

IRON COUNTY.

QUARRIES IN GRANITE.

Graniteville. In township 34 north, range 3 east, on the southern half of the line dividing sections 10 and 11, are two quarries which have been operated since 1882 by the "Syenite Granite" company. These quarries are probably the largest in the State. They are admirably located on hill slopes, which location permits of their being drained by syphons. The rock is a red granite, exposed in extensive outcrops, generally with a thin cover, necessitating little stripping. It is very easily quarried, having a good "bedding" plane, and vertical joint planes, in sufficient quantities to assist the quarryman greatly in getting out stones, and yet not so abundant as to prevent the obtaining of very large blocks. The color of this stone is red or dark pink, mottled with gray and black, the red shades being due to feldspar, the others to a more or less smoky quartz. The rock takes a high, lustrous and handsome polish; but on account of excessive hardness, it is very difficult to dress.

The plant consists of a switch about three miles long, which connects the quarries with the Iron Mountain & Southern railway, a locomotive and two stationary engines, two steam travelers, a vertical and a lathe polisher, several derricks, steam drills, an office, a store, extensive sheds, work shops, etc.

The product since 1882 is about 250,000 cubic feet of dimension stone, about 5,000,000 paving blocks, and a large amount of "rip-rap," which has been used for ballast by the Iron Mountain & Southern railway, and also extensively in the manufacture of granitoid pavement and sidewalk flags.

Structures containing this granite.

Among the important structures for which these quarries have supplied stone are the following: —

Fagin building,	St. Louis, Mo.	Rialto building,	Chicago, Ill.
Odd Fellows hall,	" "	Northwestern Guarantee Loan	
Mercantile library,	" "	Co. bldg.,	Minneapolis, Minn.
Roe building,	" "	Society for Savings building,	
Singer building,	" "	Cleveland,	Ohio.
Commercial building,	" "	Central Sav. Bk.,	Baltimore, Md.
Ligget & Meyer bldg.	" "	Union Depot building,	Indian-
Rosenheim building,	" "	apolis, Ind.	
Meyer Bros. building,	" "	City Hall bldg.,	Cincinnati, O.
Drummond tobacco		Cincinnati art museum,	" "
factory,	" "	Ætna Bank bldg.,	" "
Merchants bridge,	" "	German Savings Bank,	" "
St. Louis stand pipe		Whitney National Bank,	New
tower,	" "	Orleans,	La.
Boatmen's Bank bldg.,	" "	Morris bldg.,	New Orleans, La.
Rookery building,	Chicago, Ill.	Oriental hotel (now in construc-	
Marshall Field bldg.,	" "	tion),	Dallas, Texas.
Studebaker building,	" "	Paxton building,	Omaha, Neb.
Savory hotel,	Dubuque, Iowa.	Heest bldg.,	Kansas City, Mo.
		Corrigan building,	Kansas City, Mo.

Sizes of blocks produced.

Among the largest pieces of dimension stone which have been quarried here are: The Allen monument in Pittsfield, Mass., which is 42 feet high and $4\frac{1}{2}$ feet square at the base, and weighs about 45 tons; the columns in the front of the Studebaker building, in Chicago, which are ten in number and are each 18 feet high and $4\frac{1}{2}$ feet in diameter, and weigh about 18 tons; and the window sills in a Chicago building, on Adams street, between Fifth avenue and Franklin street, which are each 3 feet square by 17 feet 4 inches long.

Mode of occurrence and character of the rock.

H. A. Sheahan. In township 34 north, range 3 east, a little south of the "Syenite Granite" company's quarry, Mr. Sheahan opened a small quarry, in August, 1889. The manner of occurrence of the rock with reference to quarrying, and the character of the stone is similar to that of the Graniteville quarries. Little work has been done here. No dimension stone has as yet been quarried, and only a few thousand paving blocks have been produced, which were hauled in wagons to Middlebrook for shipment.

Phil. Schneider. In township 34 north, range 3 east, section 10, west half, Mr. Schneider has two granite quarries which were opened in 1885. They are situated on the west slope of a granite ridge where drainage by siphons is possible and quarrying is easily carried on. The characteristics of the outcrop and of the stone are about the same as those at Graniteville, which have been described above. The plant consists of two stationary engines, a steam traveller, six derricks, three polishers (lathe, vertical and pendulum), a short tramway, blacksmith shop, office, boarding houses, sheds, tools, etc. A railway connection, three miles long, with the St. Louis, Iron Mountain & So. ry. is contemplated. The total output to date is about six million paving blocks, in addition to an undetermined amount of dimension stone. Among the important structures for which it has furnished granite are the Lemp building, and the Moline and Merchants bridges, all of St. Louis.

Mode of occurrence of the rock.

Character.

Plant.

Production.

Uses.

Ozark Mountain. About a quarter of a mile south of Graniteville is a quarry which was opened in 1869, and which is the oldest granite quarry in Missouri. It is in the same outcrop as the Graniteville quarry and the stone answers to the same description. The quarry is not now worked, but, when in operation, from five to six hundred men have been employed here at one time. Stone from this quarry was used in the construction of the famous Eads bridge across the Mississippi, of the Illinois and Iowa State houses, of the St. Louis and Cincinnati custom houses, and of the Memphis and Little Rock post-offices. The stone taken out was, however, inferior to what can be obtained, as it was mostly surface rock.

Character of the rock.

Uses.

Pilot Knob Company. In township 34 north, range 3 east, section 22, center of southern half, there is a very small quarry belonging to the Pilot Knob company, from which a few paving blocks have been quarried. The outcrop of granite is very large here, and can probably be quarried advantageously for dimension stone, as the joint planes seem to be so situated as to facilitate quarrying, and yet not to interfere with the production of large blocks. The stone is composed of grains of clear transparent quartz and of crystals of dark pink feldspar, which latter give it a reddish color. It takes an excellent polish.

Conditions of occurrence.

Composition.

QUARRIES IN PORPHYRY.

J. S. Benson. In township 31 north, range 4 east, section 14, east half, about three miles from the railroad, is a small quarry in porphyry, opened in the spring of 1888. About 700,000 paving blocks have been produced to date here, which were shipped to St. Louis and Memphis. The rock is too full of joint planes to permit of its being quarried for dimension stone; but it splits well and is easily made into paving blocks. Its color varies from dark blue to pink.

Product.

Character of the rock.

May and Tow. In township 31 north, range 3 east, at Annapolis, is a quarry at which work has been discontinued, owing to the extreme difficulty with which the rock was worked and also on account of the numerous seams and joint planes which intersect it. The stone is a blue-black porphyry, speckled with crystals of gray feldspar. It has numerous inclusions which resemble bombs in a lava flow. About 10,000 paving blocks is the total product of the quarry.

Character of the rock.

Product.

E. W. Graves. In township 30 north, range 4 east, section 16, northeast quarter, is an outcrop which has been worked in "motions." The stone is a dark, hard and brittle porphyry which splits easily. It is fit only for the production of paving blocks, and only a very few of these have been made.

Character of the rock.

QUARRIES IN LIMESTONE.

Cartey and Mann. In township 33 north, range 3 east, section 1, near the center, are several small quarries in the magnesian limestone, which is here covered by about a foot of stripping. The color of the stone is blue in some strata, and yellow in others. The yellow variety dresses easily and makes a handsome building stone, but the blue is less easily worked and is less valuable. The strata vary in thickness from 6 inches to 2 feet. The output from these quarries has been small, and has been used mostly for foundations. They furnished stone for one small dwelling house, and for Dr. Goulding's hospital, both at Ironton, the latter a handsome edifice.

Color of the rock.

Uses.

Hastings. In township 33 north, range 4 east, section 5, southeast quarter, is a small quarry in the magnesian limestone.

It is situated on the west slope of a hill, where the workable stone is covered with a bed of stripping many feet thick. The color of the stone when fresh is a dark green which fades to a gray as the stone dries. The stone is easily dressed. It occurs in strata about 2 feet thick, two or more of which are workable. The output is small, and has been used mostly for foundations.

Color and properties of the rock.

Hollman Bros. In township 33 north, range 3 east, section 27, near Hogan, is a quarry in the magnesian limestone, about 70 feet long, 33 feet wide and 10 feet deep. It is on a hillside and is connected with the Iron Mountain and Southern railway by a short switch. The stone occurs in strata varying from one to fourteen inches in thickness. Its color is bluish, streaked here and there with drab or yellow. It does not dress easily. The output has been used entirely by the Iron Mountain & Southern railway, in the construction of bridge abutments and culverts.

Conditions of occurrence and color of the rock

Russell. In township 33 north, range 4 east, section 5, northeast quarter, is a small quarry in the magnesian limestone. The bed-rock is covered with about 3 feet of stripping of light red loam. Joint planes seem too numerous to permit the quarrying of blocks of desirable sizes for dimension work. The colors of the stone are gray and yellow, and black in the case of one non-continuous stratum of marble, which has a maximum thickness of 6 inches. The stone is very tough, has numerous veins of calc-spar and, hence, is dressed with difficulty. The product has been used in Ironton and Arcadia for foundation purposes.

Conditions of occurrence and character of the rock.

QUARRIES IN MARBLE.

Sarah P. Childers. In township 34 north, range 3 east, section 35, southwest quarter, are two or three very small openings in the out-cropping marble, which were made many years ago, and are not now worked. The marble occurs in a hill which occupies an area of many acres. The hill slope is covered mostly by a thick mantle of residuary products and detrital matter; but at several horizons marble beds crop out, and it is probable that they have a total thickness of many feet. Individual strata 18 inches thick were observed. The stone has a gray color and is mottled and streaked with green and yellow. Some of the

Conditions of occurrence and character of the rock.

Uses. mantel-pieces in the Capitol at Washington are said to have been taken from beds here exposed.

QUARRY IN CONGLOMERATE.

Shepherd Mt. On the southern slope of Shepherd Mountain is a small quarry in a porphyry conglomerate which grades into a coarse sandstone. From 2 to 10 feet of stripping of clay and boulders covers the rock. The stone is easily quarried, and dressed, but that from this locality disintegrates very rapidly on exposure to the weather, and is practically worthless for building purposes. The output, which has been very small, has gone to Ironton to be used for foundations. Some of the steps of the Iron County court house are of this stone and these are very deeply worn, compared with those of limestone with which they are associated.

Conditions of occurrence of the rock.

Character.

Product.

ST. FRANCOIS COUNTY.

QUARRIES IN GRANITE.

Milne and Gordon. In township 34 north, range 6 east, section 5, near the center, is a granite quarry which was first open in 1870, and reopened in 1876 by the present company. It is situated on the west slope of a low granite ridge and is drainable by siphons. The stripping on the rock varies in thickness from 1 foot to about 10 feet. The distribution of joint planes permits the quarrying of enormous blocks, one solid block having been broken out measuring fifty feet in length and twenty feet in width and depth. The stone is of a soft gray or pink color. Feldspar is the chief coloring mineral, and a milky quartz and black biotite serve to modify its effects. Both the gray and pink varieties take a brilliant polish. The stone is hard but dresses quite easily. It splits to best advantage along the "lift."* The plant of this company consists

Conditions of occurrence of the rock.

Character.

The Plant.

* The "lift," at the quarries described in this paper, is the name given to the plane along which the rock splits, and which is parallel to the bedding plane of the quarry. The bedding plane is the one which is nearest to horizontal in position. The plane nearest perpendicular to the "lift" along which the rock splits is called the "rift." The plane approximately at right angles to the "lift" and to the "rift" is called the "hardway."

of a tramway about a mile and a half long, two stationary engines, of 30 and 10 horse powers respectively, 6 derricks, a polishing room with a circular and a vertical polisher, sheds, tools, etc. The output of this quarry to date amounts to about 60,000 cubic feet of dimension stone and about half a million paving blocks.

Among the most important structures for which it has furnished granite, are the J. R. Lionberger and the H. L. Forks buildings of St. Louis; U. S. custom house and post-office, Marquette, Mich.; United States custom house and post-office, Keokuk, Iowa; United States Rock Island arsenal, Rock Island, Ill.; Jackson County court house, Kansas City, Mo. The largest dressed stone produced is a block ten feet square and one foot thick.

"*Syenite*." In township 34 north, range 6 east, section 5, in the northeast quarter, are two granite quarries which are controlled by the Syenite Granite company. They were opened in 1878. Work at these quarries is now suspended because the company finds it most convenient, at present, to supply the stone for all of its contracts from the Graniteville quarries. Dimension stone can be obtained here in large blocks, and the rock is quite easily dressed, and takes a high polish. The color of the stone, derived from the contained feldspar, is a pale pink, mottled with grains of milky quartz and black specks of biotite. The quarries are connected with the Belmont Branch railway by a switch, a little less than two miles long. Most of the company's working plant is, at present, at the Graniteville quarries.

Allen and Vieths. In township 35 north, range 5 east, section 36, on Doe Run creek, is a large quarry which was opened a few years ago. It is situated on the east slope of a hill, and is drainable by siphons. It is not now worked, though capable of furnishing excellent dimension stone. The rock outcrop has practically no cover, and is cut by joint planes in an advantageous manner. There are two varieties of stone: a pink, fine grained syenite, and a gray to pale pink and rather coarse grained granite, which in places is handsomely mottled with crystals of a pale green mineral. The former is apparently intrusive in the latter. The quarry has produced about 400,000 paving blocks to date.

The Output.

Important Structures.

Syenite Granite company's quarries.

Character of the rock.

Conditions of occurrence of the rock.

Color.

Product.

Motion quarries. *Motions at Syenite.* The country for several miles north, west and south of the town of Syenite, in section 5, township 34 north, range 6 east, has extensive outcrops of red granite in which the quarries, already discussed, of Milne and Gordon, Doe Run and Syenite are situated. In addition to what these quarries have produced, stone has been gotten out at a number of other localities from "motions," or other small openings, for the production of paving stone. Such are the Walsh, Ruecking & Co., O'Bannon, Abbot, Turpin, Bougeois, Cartee, Chamberlain, Crawford and the Kansas City company's motions or quarries. These granites do not offer the facilities for motion work that the syenites do, and it is usually necessary to open them by powder blasts. In general they are not intersected by many joint planes, have no great amount of stripping, and are situated so as to favor economic quarrying of dimension stone, on a large scale. They are destined to be worked extensively in the future. The characteristics of the stone, as described above in the notes on the Milne and Gordon and the Syenite quarries, are fairly representative of the stone of this whole area, although it varies locally in depth of color and in texture; the latter being occasionally very coarse. The output of paving blocks from these localities has been, approximately: from the Walsh, 200,000; Ruecking & Co., 100,000; O'Bannon, between 4,000,000 and 5,000,000; Cartee, 10,000; Crawford, 4,000, and others 5,000.

Names of owners.

The Output.

QUARRIES IN SYENITE.

Allen and Company. In township 36 north, range 4 east, section 20, southwest quarter, is a quarry in the syenite, known as the Garrett quarry, which was opened in 1887, by a blast of many tons of powder. It is not now worked. The total output to date is a little less than 100,000 paving blocks. The rock is covered with very little stripping, but joint planes and seams are so abundant that it is impossible to quarry it for dimension stone. It is fine grained, pink in color, and easily dressed.

Output.

Conditions of occurrence of the granite.

Motions at Knob Lick. In the neighborhood of Knob Lick, west of the railroad, "motion work," started some thirteen or fourteen years ago, has been extensively carried on, and there are probably not less than three hundred motions now ex-

300 motions near Knob Lick.

isting, though not all at present worked, within a few miles of the depot. They are most numerous in the syenite outcrops which occur in sections 4 and 9, in township 34 north, range 6 east.

The motions are mostly on the lands of Messrs. Price, McDowell and Simpson to whom the "motion men" pay a royalty for each paving block made. The total product to date of these syenite motions is about 17,000,000 paving blocks.

The syenite is here exposed over an area of perhaps a square mile. On the eastern side of this area it disappears beneath the thick, overlying beds of Second Sandstone, while, on the western side, it rises topographically into a high peak, known as the Knob, the summit of which is composed of a very fine grained, pink, porphyritic felsite. The relation of this felsite to the syenite is not clear. From the summit of the Knob, down the western side, the felsite passes by apparent gradations, into a coarse grained, red or pink granite. On the north and south it is surrounded by sandstone or granite. The syenite is covered with an extraordinary amount of stripping, the surface being strewn with loose boulders, beneath which lie, *in situ*, boulders and decayed rock to a depth, often, of many feet. The stone varies in color from a light to a dark gray, which is locally called blue (the stone being known as "blue granite"). It is fine grained, splits and dresses easily, and is well adapted for the production of paving blocks. It takes an excellent polish, but has not yet been produced as dimension stone.

Relations of the
felsite to the
syenite.

Conditions of
occurrence.

Color.

QUARRIES IN PORPHYRY.

Motions at Knob Lick. In township 34 north, range 6 east, section 9, on what is known as the "Knob," are several motions and very small quarries where a porphyritic felsite is worked into paving blocks. The rock is too hard to be dressed, and is so cut up by joint planes that it will probably never be quarried for dimension stone, although it is very handsome and is remarkably durable and strong. The production of paving blocks from this rock has been small.

Character of the
rock.

QUARRIES IN LIMESTONE.

St. Joe Lead Co. In township 37 north, range 4 east, section 23, near Bonne Terre, are several small quarries in the limestone.

Conditions of occurrence of the rock. The stone is easily quarried in open cuts on the hill-sides, where the stripping is very light. The strata vary in thickness from six to eighteen inches, and blocks of large area can be obtained.

Character. The color of the stone varies from blue to gray, growing lighter as it dries after quarrying. It is dressed with some difficulty, owing to numerous veins of calcspar which it contains. It is used largely in and about Bonne Terre for foundations, edge stones, paving, flagging, etc. The dwelling house of Superintendent Parsons is built of it, and it is there shown to be a very handsome and durable building stone.

Uses.

P. V. Ashburn. In township 36 north, range 6 east, section 31, southwest quarter, is a limestone quarry, sixty feet square and twelve feet deep. The limestone is covered by about thirty inches of stripping. The strata vary in thickness from three to eight inches. The color of the stone varies, being yellow, gray and blue. The product is used mostly for macadam, and to some extent for foundations and flagging.

Conditions of occurrence and character of the rock.

J. B. Miller. Mr. Miller has a quarry in limestone similar to Mr. Ashburn's, in the southeast quarter of the same section. The rock, however, is covered by several feet of stripping. It is used for foundations.

A. Parkhurst. In township 35 north, range 5 east, section 2, near the center, is a small quarry in the limestone from which about sixteen hundred cubic feet of stone have been taken, to be used for macadam.

M. P. Cayce. In township 35 north, range 5 east, section 1, southwest quarter, is a limestone quarry which has furnished a small amount of stone, of a poor quality, for foundations in and about Farmington.

J. M. Elvins. In township 36 north, range 4 east, section 12, southwest quarter, is a limestone quarry, in a stone of a yellowish color, which dresses easily. The maximum thickness of any stratum is twelve inches, and blocks of large area are obtainable. The quarry has furnished considerable flagging for Farmington, and also the sills for the Elmwood academy.

Mrs. F. E. Toleman. In township 36 north, range 4 east, section 13, southeast quarter of the southeast quarter, is a limestone quarry. It is an open cut, on a hill-side, about seventy

feet long and twenty feet wide, with an extreme depth of eight feet. The rock is covered by about four feet of stripping. The stone varies in color from yellow to gray, is fine grained, tough and hard, and is dressed with difficulty. The product has been used for foundations only.

Jno. Rothney. In township 35 north, range 3 east, section 5, northeast quarter of northeast quarter, is a limestone quarry, about one hundred yards long, forty feet wide and twenty feet deep. About three feet of stripping covers the rock. The strata vary in thickness from two to fourteen inches and blocks of large surface area are obtainable. The stone is somewhat siliceous, and varies in color from yellow to pink and chocolate. The output has gone almost wholly to the railway company for the construction of bridge abutments and culverts.

Conditions of occurrence and character of the rock.

Beals' Quarry. In township 35 north, range 5 east, section 1, northeast quarter, is a quarry in which the limestone is porous, filled with calcite veins and pockets, and unfit for building purposes. The output has been used principally for macadam and foundations.

J. M. Ritters. In township 36 north, range 5 east, section 23, northeast quarter, is a quarry in the limestone where blocks as large as ten feet square by eighteen inches are obtainable. The stone is fine grained, gray to yellow in color, and dresses very easily. The output has been used mostly for monument bases, window sills, etc.

St. Joe Lead Company, North Quarry is in township 38 north, range 4 east, section 35. The strata vary from six inches to two feet in thickness, and large slabs are obtainable. The stone varies in color from gray to yellow, is coarse grained, dendritic, and occasionally blotched with calcite crystals. It does not dress easily. The output has been used for piers and abutments for a railway bridge over the Big river, and for the construction of drains and culverts. It has also been crushed and used largely for ballast in the construction of a railway bed.

Character.
Uses.

QUARRIES IN SANDSTONE.

Knob Lick Quarries. Close to the railway, about half a mile north of Knob Lick, are several small quarries in the sandstone

Thickness.	which are not at present worked. The sandstone has here, probably, an aggregate thickness of one hundred feet only, and consist of strata which vary from one to twenty inches in thickness. Only a few of these strata have any value for building stone and they disintegrate so rapidly that they are scarcely worth quarrying. Stone from the thickest and most compact strata have been used, to a small extent, for foundations at Knob Lick, but the chief use has been by the railway company in the construction of culverts and abutments. An examination of some of the stone in these abutments showed it to be in a badly crumbled condition, and seriously needing replacement by stronger and more durable material.
Uses.	
Character.	

MADISON COUNTY.

QUARRIES IN GRANITE.

Character of the rock.	<i>Milne and Gordon.</i> In township 33 north, range 7 east, section 25, northeast quarter, are two small quarries in a granite ledge, which were opened in 1886. The granite here is capable of furnishing large blocks of dimension stone, has very little stripping upon it, and is conveniently near the railroad. The stone has a dark reddish color, due to a prevailing feldspar, and is beautifully mottled with grains of translucent quartz and dark specks of biotite or hornblende. It takes a high lustrous polish and makes a very handsome stone for ornamental purposes. It does not dress very easily, however. The total output of the quarries to date amounts to about five thousand paving blocks and a small amount of dimension stone. These quarries will soon be developed on a large scale by the present owners.
Output.	

QUARRIES IN DIABASE.

Conditions of occurrence and character of the rock.	<i>Kansas City Company.</i> About three miles west of Mine La Motte station at Skrainka, are some large quarries in an outcrop of diabase, which is probably an intrusion in the granite. They are not now worked. The rock is covered with from ten to thirty feet of stripping, and has been so violently contorted and broken, that it is impossible to quarry dimension stone from it.
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It is fine grained, dark gray to almost black in color, splits and dresses easily, and takes an excellent polish. The effects of weathering, as exhibited in the outcrops, would lead one to the conclusion that this is not a durable stone. Efforts made to quarry it for monumental purposes failed on account of the seams above spoken of. About 2,000,000 paving blocks have been produced here to date. Product.

QUARRIES IN MARBLE.

H. L. Gale. About eight miles south of Fredericktown, on the farm of Mr. Gale, a small opening was made in a marble outcrop, about ten years ago. Two strata of marble are exposed here, one being about seven inches thick, and the other about eighteen. The thinner stratum of these has a pale pink color which shades into a lavender, and is relieved by specks and streaks of calcite, arranged in parallel lines, giving the whole stone a subdued but very handsome effect. It takes an excellent polish. The thicker stratum has a pale grayish tint, slightly variegated by green and brown streaks. These marbles are fine grained, and are somewhat "plucky" under the stone cutter's tools. It is probable that there are several strata of good marble here; but the beds of residuary products make it difficult to determine this fact on a cursory examination. Only one car load has been shipped from here, which went to St. Louis. Thickness of the beds.
Color of the rock.

Cedar Bottom Quarry. In township 33 north, range 5 east, section 36, northwest quarter, a stratum of dark red variegated marble, which takes an excellent polish, has been opened on. Only a very small amount of stone has been taken out, however, and this mostly for samples. Character of the rock.

L. M. Hebener. In township 32 north, range 5 east, section 17, southwest quarter of the southwest quarter, a small marble quarry was opened some time before the civil war. The best stratum is about eighteen inches thick. The marble is of a light gray color, variegated with streaks of brown and green. It takes an excellent polish, but needs to be dressed with care, owing to its "plucky" qualities. Several car loads were shipped to St. Louis. Thickness of the stratum.
Qualities.

Developments. *Slater Quarry.* In township 33 north, range 6 east, section 23, south half, a marble quarry has been worked intermittently for about fifteen years. A heavy stripping was removed over an area of about seventy-five square yards, and a shaft was sunk through about eighteen feet of marble strata. The quarry is now full of water. Blocks lying about show that some of the strata are at least twenty inches in thickness. The marble varies considerably in color, the handsomest variety resembles the thinner stratum in Gale's quarry, described above, but it has a redder shade. These marbles take an excellent polish, but are quite "plucky." A few small shipments have been made.

Character of the rock.

Wright's Quarry. About a mile and a half east of Gale's quarry, on the Fredericktown road, a small quarry was opened, in the marble, ten years ago. The thickness of the beds here could not be ascertained. The marble has a dark brown or chocolate color, which is relieved by veins of calcite. It is fine grained, and takes an excellent polish, but is "plucky," like the last described. Two car loads were shipped to Boston and New York.

Character of the rock.

T H E
MINERAL WATERS OF SALINE COUNTY.

By A. E. WOODWARD, assistant geologist.

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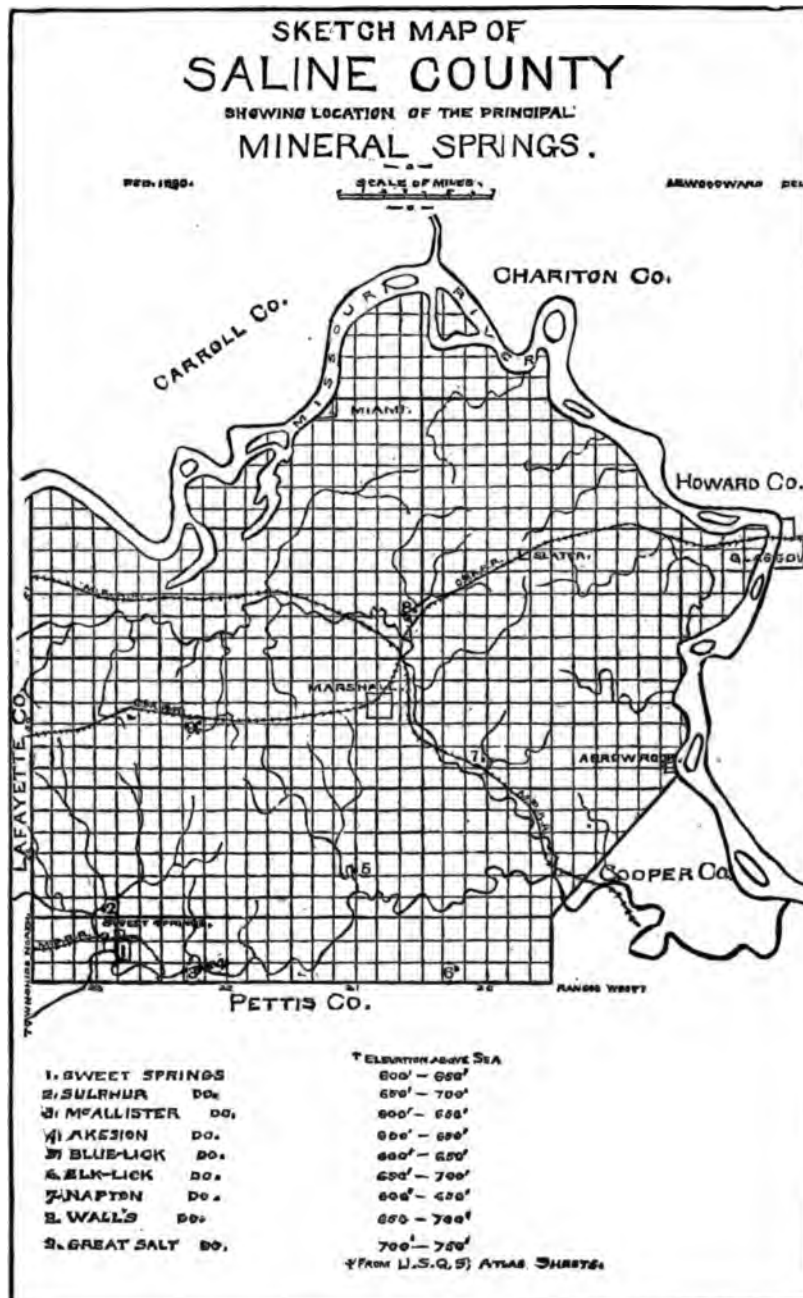
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PREFATORY REMARKS.

The field work for the following article by Mr. Woodward on the mineral waters of Saline county was done during the month of February, and, despite the inclement weather, occupied only about fourteen days. The beginning of the subsequent laboratory work was delayed until March 22nd, through failure to receive various chemicals and supplies, and it is only by the most unremitting efforts on Mr. Woodward's part that we are now able to present his results.

This paper is one of a series which it is intended to publish on the mineral waters of the State. The examinations will be carried on by counties and the results will be made public, as soon as is possible, in publications similar to this. After all of the important waters of the State have thus received attention successively, a comprehensive report on the mineral waters of the whole State will be issued.

Mr. Woodward has described and indicated the best uses to which the waters of Saline county can be put and their relative values for the various



uses can be judged of from the table of analyses. The similarity in composition between some of these waters and those of noted Kentucky springs is interesting and suggestive. Many important questions in connection with these mineral waters, such as their origin, the source of the salt, their geographic extent and geologic horizon, have not been dwelt on here, and cannot be discussed until more detailed field work has been done, and until the investigations have extended over wider areas. Such matter will belong properly in a final report or monograph.

ARTHUR WINSLOW, State geologist.

INTRODUCTION.

Saline county, situated in the west central part of Missouri, and having the Missouri river for its northern and eastern boundary, has long been noted for the large number of salt springs within its limits, which facts suggested its name. The majority of these springs are very salty, and would, undoubtedly, be classed as "saline springs." In connection with the salt water many of them give off quantities of hydrogen sulphide gas, and are locally known as "sulphur" springs. The temperatures of all are nearly the same, and the flow remains constant, independent of rain-fall. They are all probably of deep-seated origin, and are not thermal. From the waters of many of the larger ones, salt was manufactured years ago by evaporation over fire. This work has now been abandoned, and the waters are now used extensively as beverages, or for medicinal purposes. The location of the principal springs is shown quite accurately on the accompanying sketch map. Numerous springs exist which are not shown individually on the map; but, of these, many are closely associated with the larger springs, and all are small and do not differ in character from those to be described. Among those not shown on the map are: —

- a. A spring at Arrow Rock, having a good flow, which was formerly a salt-sulphur water, but which is now reported by its owner to be very weak in saline matter.
- b. A salt-sulphur spring near Miami, section 35, township 53 north, range 21 west, the property of A. J. Caseboat.

Location of Saline county.

General character of the springs.

Their location.

- c. A sulphur spring near Shackleford (between Great Salt Springs and Marshall) in section 1, township 50 north, range 22 west, owned by James Prior, and reported to be a weak salt spring.

Springs at Grand Pass. Some springs of strong flow and clear water also occur along the Missouri bluffs at Grand Pass, but they can hardly be classified as mineral springs. Some are slightly chalybeate and small quantities of oil have been found in connection with them; but the flow of oil has been very weak. Several years ago, on sinking a well at Malta Bend, in section 3, township 51 north, range 22 west, oil was struck; and gas has been reported from the vicinity of Elmwood, section 3, township 49 north, range 23 west.

Most of the salt springs of this county are found in the vicinity of Salt-fork and Black-water branches of the Lamine river, and seem to be limited to the valleys of these streams. An important exception to this is the Elk Lick spring in the Lamine river valley itself.

A DESCRIPTION OF THE SPRINGS.

SWEET SPRING.*

Improvements at Sweet Springs. Sweet spring is decidedly the best known in Saline County; it is in the southwest corner of the county in the northwest quarter of section 14, township 48 N., range 23 W., about one mile south of the railroad station at Sweet Springs. A hotel, bath house, and other houses have been built here, and the locality is a recognized summer resort. The Sweet spring itself (so called from its lacking any salty or strong mineral taste) issues from a bluff of crinoidal limestone, some twenty-two feet above the low water mark of Black Water. This is the only locality where the water can be seen emerging from the rock so that the exact horizon of its occurrence can be determined. It flows at the rate of about 1100 gallons per hour from a crevice in the limestone of about 50 square inches in area. A remarkable fact

Rate of flow.

* The results of analyses of the water of this, and of other springs hereafter described, will be found in the tables on pages 56 and 57 of this article.

concerning this water, when compared with that of other similar springs in the county, is that, although a deep-seated spring, as evidenced by its regularity of flow, temperature, etc., it contains such an extremely small proportion of saline matter as to be hardly recognized by taste. It is, moreover, destitute of sulphuretted hydrogen and shows a small amount of carbonic acid gas at the spring.

The water flows into a walled basin five feet in diameter and fourteen inches deep, with a cemented porcelain bottom. Thence it is forced into the bottling house, where large quantities are bottled and shipped to various points in the State, and elsewhere. The temperature of the water in the basin was 53.3° F., that of the air being 41.5° F. About twenty feet below the level of Sweet spring, a few feet above Black Water creek, is a "sulphur" spring. It has constant flow, but is covered by the Black-water in times of freshet.

BLACK SULPHUR SPRING.

Two miles north of Sweet Springs, near Davis creek, is a group consisting of six or more sulpho-saline springs. Of these, the largest and best known is the "Black Sulphur" spring, in the southwest quarter of section 34, township 49 N., range 23 W. It issues from the bed of Davis creek and is submerged at times of high water. The water has a very slight saline taste and is very palatable; it is charged with hydrogen sulphide gas, and deposits sulphur where exposed to the air. The other springs of this locality are of the sulpho-saline variety with limited flows and of only local importance. The whole region along Davis creek, and along Blackwater near Sweet Springs, furnishes salt springs, or at least salty seeps, and most of them are sulphuretted.

MCALLISTER SPRINGS.

These springs are found in the northeast quarter of section 17, township 48 N., range 22 W., about five miles east of Sweet Springs and close to Blackwater creek. The principal springs are three in number, known respectively as the Black Sulphur, White Sulphur, and Salt springs. The Black Sulphur and Salt springs occur near each other and are both saline and sulphuret-

ted; the Salt spring water seems to contain more gas than the other. From the Salt spring is deposited a reddish white precipitate of sulphur, while the Black Sulphur is characterized by a black sediment composed of sulphur and organic matter mixed with clay and fine sand. A small amount of the black sulphur water is bottled and shipped away; but most of it, mixed with the "Salt spring" water, flows into the bath houses. The White Sulphur spring is a few hundred feet nearer the Blackwater and is well protected from the weather. It is saline like the other two.

Temperatures.			Water.	Air.
	Temperature	Black Sulphur springs	57.7° F.,	33° F.
	"	White "	52° F.,	33° F.
	"	Salt "	58° F.,	33° F.

AKESION AND SALT SPRINGS.

About one mile below this group, on the north side of the Blackwater, in the northwest quarter of section 16, township 48 N., range 22 W., occur the "Akesion" and Salt springs. They are about 300 feet apart, both flowing from the alluvial clays. They are both saline and sulphuretted and appear to flow from a common source. The medicinal properties of the two, it is claimed, however, are quite distinct, the Akesion water being bottled and shipped away, while the salt spring water (together with the Akesion) is pumped over four miles to the Sweet Springs grounds, where it is used in the bath house.

Both springs deposit sulphur (white and flocculent) along their courses. Their temperatures are as follows:—

Temperatures.			Water.	Air.
	Salt Springs.....	58.8° F.	40° F.	
	Akesion.....	59.7° F.	35° F.	

BLUE LICK SPRINGS.

Passing down Blackwater, on Finney's creek, about one mile from its mouth, we find the group known as "Blue Lick springs," located in the southeast quarter of section 21, township 49 N., range 21 W. Here a number of sulpho-saline springs are scat-

tered along Finney's creek from its junction with the Blackwater; but they culminate at Blue Lick where several such springs occur within a radius of a quarter of a mile. Fresh water springs are common and one, which when visited was flooded with water, is reported to be very bitter or "magnesian" when the surface water is low. As the fresh water springs are somewhat dependent on rainfall, are colder than the sulphur springs, and lack salt, they are probably surface springs and not connected with those from a deep-seated source.

The "Blue Lick" spring is the highest of the group and is thus less affected by the floods of Blackwater creek. It is sulpho-saline in character and deposits sulphur. Its temperature is 54.7° F., that of the air being 40° F.

At least four or five of the springs here used as beverages could be classed as "black sulphur" or better, as sulpho-saline springs. One of these has been protected by a tile sunk around it and is more generally used than the others of its class. Its temperature is 55.7° F., that of the air being 42° F.

The "Gum spring" is the largest of the group and is said to furnish, and apparently flows at a rate of about 3,000 gallons of water per hour. Like the others, the water is sulpho-saline. It is allowed to flow into a large wooden basin 40 feet square and 4 or 5 feet deep, which is used for bathing purposes. On the sides of the basin, sulphur is deposited in very considerable quantities. This sulphur is the so-called "white flocculent precipitate." It is the well known accompaniment of sulphur springs and is derived from the oxidation of the sulphuretted hydrogen gas in the water, of which gas, the sulphur remains in the form of a precipitate. The terms white, black and red sulphur apply to the pure or impure precipitates of sulphur in the springs. The water itself issues from a large "gum" and a great quantity of gas is continually escaping (probably carbonic acid gas). The water is used for bathing purposes entirely. The springs are much frequented during the summer months, and the waters of "Blue Lick" and Black Sulphur springs are also shipped to Marshall in small quantities.

A short distance south of this group occurs a "sulphur" spring very slightly saline. It is neglected, however, and its true flow could not be seen.

Salt manufacture. Salt was made from the various springs here several years ago and the lines of ditches where the kettles were placed and the water evaporated can still be seen.

ELK LICK SPRINGS.

On crossing the divide between Blackwater creek and Lamine river, in the southeastern part of the county, we find the Elk Lick springs situated on Heath's creek, in section 17, township 48 N., range 20 W.

Character of water. One principal spring here is surrounded by smaller ones. The spring has remarkably clear, palatable water, charged with carbonic acid gas and slightly sulphuretted. It flows at a rate of between 500 and 800 gallons per hour and deposits a very small amount of sediment, mostly of a black color. These springs are occasionally resorted to by excursion parties; but they have little more than a local reputation.

Rate of flow.

Uses.

THE CAMP CREEK GROUP.

Character of water. The first group met on the Salt Fork river occurs near Napton. The Camp Creek group of sulpho-saline springs is located in the southeast quarter of section 28. The various springs flow immediately from alluvial clays, the underlying rock being, probably, limestone. The springs are a dozen or more in number which, flowing together, constitute the "Salt branch" of Camp creek. They are all sulpho-saline. They are included in about five acres of ground, within which area they are reported to be constantly changing their position. Salt was made here quite extensively before the war and the posts can still be seen where evaporation was carried on. In the northwest quarter of section 34 occurs a slightly saline, sulphur spring, the water of which is reported to have medical properties.

Manufacture of salt.

East of Marshall, near the Salt Fork, occur two or three salt soeps which were formerly good sized springs; and about one and a half miles east of town, is a neglected bath house, formerly supplied with water by a sulpho-saline spring. It is now entirely abandoned and the spring partially choked up.

On Cow creek, a tributary of the Salt Fork, in sections 24 and 25, township 31 N., range 21 W., a number of sulpho-saline

springs are found belonging to J. Wall and Martin Zimmerman. They are sulphur springs slightly saline. Those occurring on Wall's land have a local reputation. From this point on, up the Salt Fork, the springs seem to disappear or to assume small proportions.

THE GREAT SALT SPRINGS.

On traveling up the Salt branch, a small tributary of the Salt Fork, we find, about eight and one-half miles west of Marshall, in sections 17 and 20, township 50 N., range 22 W., the group known as "The Great Salt springs." It consists principally of two large springs, but there are numerous other smaller springs and seeps near these two. The largest and at present the most important is a sulpho-saline spring, now known as the "Sulphur spring," in the southeast quarter of section 17, township 50 N., range 22 W., only a short distance south of the Chicago and Alton railway.

It is found in a basin five feet below the general level of the alluvium. This basin is nearly circular, about 20 to 25 feet in diameter and 10 to 15 feet deep. The water flows at a rate of at least 10,000 gallons per hour; it is very salty and deposits sulphur for hundreds of feet along its course. This spring is undoubtedly the largest of any in the county, but the area of its basin is gradually being reduced by the wash from the farmed lands around it. Salt was made here formerly in considerable quantities.

The other of these two large springs situated in the northeast quarter of section 20, township 50 N., range 22 W., is a salty spring, with very little if any sulphuretted hydrogen present, distinguished as the "Salt spring." In marked contrast to the Sulphur spring is this one, the flow of which can not exceed 200 gallons per hour, though occupying a basin 25 feet in diameter and 7 feet deep. The temperature of the water of this spring was 36° F., that of the air being 20° F., while at the sulphur spring the thermometer registered 57.2° F., with the air at 14.5° F.

In Meek's report, made twenty years ago, the Salt spring was given a temperature of 59° F., with a flow at least half as strong as that of the Sulphur spring and was also stated to contain sulphuretted

Sulphur spring.

Improvements.

Rate of flow of water, character.

Salt manufacture.

Salt spring.

Flow.

Temperature.

TABLE OF ANALYSES OF SALINE COUNTY MINERAL WATERS.*

	Sweet Spring, at Sweet Springs.		Salt Spring, near Akelson.		Akelson.		Black Sulphur Spring, at McAllister's Springs.		Sulphur Spring, at Great Salt Springs.		Salt Spring, at Great Salt Springs.		Elk Lick Spring.		Napton.	
	Pts. in 1000.	Gra. per Gal.	Pts. in 1000.	Gra. per Gal.	Pts. in 1000.	Gra. per Gal.	Pts. in 1000.	Gra. per Gal.	Pts. in 1000.	Gra. per Gal.	Pts. in 1000.	Gra. per Gal.	Pts. in 1000.	Gra. per Gal.	Pts. in 1000.	Gra. per Gal.
Sodium Chloride.....	1.6877	98.79	15.0526	892.26	14.8906	882.57	10.8818	686.53	23.8345	1423.53	23.2564	1387.92	8.0184	176.68	17.4852	1038.90
Potassium Chloride.....	.0004	.05	.1655	9.81	.0903	5.36	undet.	undet.	undet.	undet.	undet.	undet.	undet.	undet.	.1680	9.81
Calcium Chloride.....	.1879	11.04	1.8220	108.00	1.4397	85.33	.7578	44.54	2.1205	126.65	1.8136	108.32	.0769	4.51	1.9744	117.31
Calcium Sulphate.....	.1490	8.80	.9591	56.85	.9426	55.87	.6857	40.30	2.0074	119.90	1.9728	117.73	.3516	20.60	1.7219	102.31
Calcium Carbonate.....	.2643	15.47	.2944	17.45	.5441	32.25	.6561	38.56	.3680	22.01	.3420	20.41	.2850	16.70	none.	none.
Magnesium Chloride.....	.3751	21.96	1.4912	88.39	1.5097	89.48	1.0973	64.50	1.9210	114.74	1.7270	103.07	.3894	22.82	1.4096	88.76
Alumina, with trace of Iron.	.0022	.13	.0018	.11	.0034	.20	.0014	.08	.0018	.11	.0017	.10	.0026	.12	.0080	.18
Silica.....	.0053	.32	.0048	.28	.0053	.31	.0044	.26	.0086	.50	.0066	.39	.0068	.40	.0080	.47
Total.....	2.6728	156.56	19.7914	1173.15	19.4257	1151.37	14.0345	824.37	30.2618	1807.44	29.1201	1737.94	4.1271	241.83	22.7701	1352.74
Total Solids.....	2.8630	167.80	20.3852	1208.30	19.9000	1179.68	14.1090	829.28	30.7120	1834.34	29.8070	1778.86	4.2800	251.12	24.4800	1453.58
Undetermined.....	.1902	11.24	.5938	35.15	.4743	28.31	.0745	4.41	.4502	26.90	.6869	40.92	.1530	9.29	1.6899	100.84
Specific Gravity at 60° F....	1.0023		1.0150		1.0149		1.0064		1.0227		1.0219		1.0033		1.0174	
Temperature of Water.....	53.3° F.		58.8° F.		59.7° F.		57.7° F.		57.2° F.		56.0° F.		56.2° F.		55.2° F.	
Temperature of Air.....	41.5° F.		40.0° F.		35.0° F.		38.0° F.		14.5° F.		20.0° F.		35.0° F.		37.0° F.	
Flow in Gallons per hour...	1100		4680		3276		800		10000		200		800		3000	

* All analyses of this table were made in duplicate.

TABLE OF ANALYSES.

ANALYSES OF MINERAL WATERS OF OTHER STATES.																				
SALINE COUNTY.*																				
	Blue Lick Spring, at Blue Lick.		Black Sulphur Spring, at Blue Lick.		Gum Spring, at Blue Lick.		Upper Blue Lick Spring, Kentucky.		Lower Blue Lick Spring, Kentucky.		Congress Spring, Saratoga, N.Y.		Union Spring, Saratoga, N.Y.		Sea Water.		Marsena Springs, New York.		Paroquet Springs, Kentucky.	
	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Pts. in 1000.	Grs. per Gal.	Grs. per Gal.	Grs. per Gal.	Grs. per Gal.	Pts. per 1000.	Grs. per Gal.	Grs. per Gal.	Grs. per Gal.	Grs. per Gal.	Grs. per Gal.	
Sodium Chloride.....	6.9765	410.32	15.9492	945.68	21.4817	1280.38	516.54	8.8473			434.40	453.30	27.05		76.79	309.60				
Potassium Chloride.....	undet.	undet.	undet.	undet.	undet.	undet.	1.80	.0227			{ Sodium Carbonate 16.00	{ 8.73	.76		.....	.48				
Calcium Chloride.....	.5530	32.56	.7452	44.18	1.7162	102.29	{ Potassium Sulphate. 12.97					{ Sodium Bicarb. 17.01	trace.		.....	67.71				
Calcium Sulphate.....	.6687	39.33	1.4886	88.27	1.8873	112.49	44.18	.5533					1.41		60.08	2.28				
Calcium Carbonate.....	.3053	17.96	.7665	45.45	.4588	27.35	25.06	.3850			144.00	{ Calcium Bicarb. 96.70	.04		4.85	2.40				
Magnesium Chloride.....	.7832	46.07	1.5098	89.53	1.9000	113.26	37.72	.5272			{ Magnes. Bicarb. 32.00	Alumina. .32	3.66		29.98	48.08				
Alumina (trace of Iron).	.0017	.10	.011	.06	trace.	trace.	{ Magnes. Bromide. 3.80	Mag. Brom. & Iod. .0040				{ Magnes. Bicarb. 109.69			.....	.....				
Silica	.0097	.57	.0092	.55	.0070	.41	1.00	.0179			trace.	2.65			.....	.....				
Total	9.2981	546.91	20.4696	1213.72	27.4510	1636.18									.....	.....				
Total Solids	9.5100	559.42	20.7500	1230.48	28.6610	1708.31	660.17	10.3000			636.40	696.17	35.23		191.88	.....				
Undetermined.....	.2119	12.51	.2804	16.76	1.2100	72.13									.....	.....				
Specific Gravity.....	1.0071		1.0153		1.0206								1.0276		.....	.....				
Temperature Water.....	54.7° F.		55.7° F.		55.2° F.		60.0° F.	62.0° F.				48.0° F.	.....		45.0° F.	.....				
Temperature Air	40.0° F.		42.0° F.		42.0° F.			.....				.....	.....		.....	.....				
Flow Gallons per hour ..	500		500		3000		1200	300				12.0	.....		700	.....				

* All analyses of Saline County Mineral Waters were made in duplicate.

THE ANALYSES.

Mode of collect-
ing samples.

From eleven of these springs, one gallon samples were taken and subjected to analysis. The water was filtered at the springs, so that all foreign matter was eliminated, and the temperatures both of the air and of the spring were noted. The bottles were sealed with paraffine to prevent, as far as possible, access of air to the water.

Nature of results.

An exhaustive analysis was not attempted, but merely such a determination of the principal constituents as would enable one to ascertain the possible uses to which these waters might be put. The results have been expressed in parts per one thousand, according to recent practice, and in grains per gallon in order to facilitate comparison with older analyses of other waters.

Differences be-
tween the min-
eral waters of
the county.

A great difference exists between the compositions of the different mineral waters in the county and this difference is found to be dependent upon the proportion of sodium chloride, or common salt, in solution. To summarize, roughly, the springs may be grouped by their contents of saline matter as follows: —

Salt contents.	a.	1-5	parts	saline	matter	per	1000	{	Sweet Springs.
								{	Elk Lick Spring.
	b.	5-15	"	"	"	"	"	{	Blue Lick Spring.
								{	McAllister [Black sulphur].
	c.	15-25	"	"	"	"	"	{	Salt Spring near Akesion.
								{	Akesion Spring.
								{	Springs at Napton.
								{	Black Sulphur at Blue Lick.
	d.	25-35	"	"	"	"	"	{	Sulphur Springs at Great Salt Springs.
								{	Salt " " " " "
								{	Gum Spring, " Blue Lick. "

Comparison with
New York and
Ohio brines.

If we take the last group, d, as representing the largest proportion of salt, and compare it with the brines of the salt making districts of New York and Ohio, as given in the table below, we find that the strongest salt springs of Saline county have a much lower salt contents than these brines. With the present low price

Comparison with
sea water.

of salt and with the competition of localities possessing much stronger brines and cheap fuels, the making of salt on a commercial scale from these waters can hardly be profitable. The springs of group d are very closely allied to sea water in composition and specific gravity (see following table), and for bath-

ing purposes would approach such water in their efficacy. As a matter of fact the waters of Gum springs at Blue Lick and the salt and Akesion springs of group c are used for bathing purposes with the beneficial effects of sea water.

Value for bathing purposes.

	Sulphur Spring at Great Salt Springs.	Gum Spring at Blue Lick.	Average of Onondago Brines, N. Y.	Average of Brines, Ohio.	Sea Water.
Specific gravity.	1.0227	1.0206	1.1360	1.1996	1.02757
Per cent. salt.	3.14	2.80	18.55	23.91	3.52
Pounds of salt in one gallon.	.28	.21	1.755	2.565	.25

The county possesses an abundance of palatable mineral waters which compare favorably with other springs of its class in the United States. The springs all differ from the noted springs of New York by the absence of the large amounts of carbonates and bicarbonates which are in the New York waters. With the springs of Kentucky, however, they are more closely allied, and the resemblance between the waters of the Blue Lick springs of that State and those of Saline county is very striking. The medicinal value of Sweet spring, Akesion spring, McAllister spring and Blue Lick and Sulphur springs at Blue Lick would seem to be sustained by the experience of people using the water for several years. The waters of groups a and c, containing the smaller amounts of saline matter, are more palatable than the saltier waters and consequently will deserve the preference as beverages. And in this connection the close association of these palatable waters with such large quantities of saline waters suitable for bathing purposes, is a happy combination.

The waters as beverages.

Comparison with Kentucky waters.

A PRELIMINARY CATALOGUE
OF THE
FOSSILS OCCURRING IN MISSOURI.

BY G. HAMBACH, palæontologist.

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PREFATORY REMARKS.

Fossils are the remains or the casts "of things once alive and flourishing;" things which, like those at present living, bore in their forms the imprint of the times and of heredity. As different plants and animals do now characterize different climates, or different soils, or different waters, so do different fossils characterize the changed conditions represented by the various formations or rock groups of Geology. A man, transported unconsciously to a foreign and strange land, would gain some clue as to his whereabouts by a study of its inhabitants, its animals and plants, and of their customs. So the palæontologist, by a study of the inhabitants of the rocks, helps to determine his location geologically, and assists in assigning to their proper places the rocks which are encountered. Thus, are fossils guides in geologic work, and thus, — contrary statements notwithstanding, — have fossils an almost direct money value; for, the successful determination of the position or geologic age of rocks, leads often to results of great economic value. But, true it is, that, along with this money value of these remnants of ancient life, goes one of such fascinating interest, of such philosophic importance in its relations to the great question of the history and development of life, that the first consideration becomes often so dwarfed as to be entirely overlooked, and the last grows all absorbing, and is often pursued regardless of immediate objects.

The catalogue of fossils, herewith published, is offered as an attempt to present in a definite form a statement of the status of our knowledge of the palæontology of the State at the present time. Were such a catalogue the result of exhaustive work, and did it express final results, then, an *ultima thule* in palæontologic inquiry would have been reached; at least so far as relates to its economic applications. But such a work this catalogue cannot pretend to be; it is to a great extent a compilation; the fossils given have been collected and determined by different men and on different occasions, while engaged on different works. Stratigraphic work has not been prosecuted along with the collecting, and the details of the stratigraphy of the State have not been sufficiently defined for the horizon of any outcrop, in which specimens may have been found, to be asserted without doubt. And as there is, thus, a certain indefiniteness concerning this local rock column and concerning the distribution of its members, so is there likewise doubt concerning the correlation of the formations of this State with those of others. Thus the adoption, in this catalogue, of the classification of Shumard, based upon the New York section, must not be interpreted

as an expression of results reached, or of opinions held by this Survey. It is hardly to be expected that all of the conclusion of early past work, much of which was mere reconnoissance, could stand as final. What detailed work may develop cannot be stated here.

Thus, this publication is offered as a purely provisional one; as a working list for reference in field and office; to be criticised, to be fought over, to be amended, to be improved, that later it may reappear in maturer form, unassailable, a guide for the strong, a support for the weak.

ARTHUR WINSLOW, State geologist.

INTRODUCTION.

The following catalogue of fossils contains, so far as is known, the names of all species occurring in Missouri, excepting such as are new and undescribed. All insufficiently known species have been omitted, and for a number of others the old generic names have been retained, in order not to increase the number of synonyms; especially in such cases where their propriety is doubtful.

The classification is a zoological and botanical one and, at the head of each sub-kingdom, is a table giving the classes, orders, families, and genera included in it. The species of each class are arranged in alphabetical order. The number in front of the names of the species refer to corresponding numbers in front of the family names to which the species belong. The supposed geological horizon is indicated by a dash in the appropriate columns, and the locality where each species has been obtained is also given. It is not to be understood, however, from this catalogue, that the localities given are the only localities in which the particular species may be found; on the contrary, future discoveries may bring to light others and even better localities than those mentioned in the list.

ANIMAL KINGDOM.

SUB-KINGDOM PROTISTA.

1. CLASS — RHIZAPODA.

2. CLASS — PORIFERA.

NAME.	LOWER SILURIAN.		UPPER SILUR.		DEVONIAN.		SUB-CARBONIFEROUS.					LOCALITY.				
	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.		St. Louis.	Chester.	COAL MEASURES.	PERMIAN.
<i>Fusulina cylindrica</i> , Fischer.....																Jackson Co. Andrew Co.
1 <i>Ptylostylus heterocostalis</i> , Gurley.....																Jackson Co. Pike Co.
2 " <i>subtumidus</i> , ".....																
2 <i>Palaeacis</i> , Halme 1869.....																Clark Co.
2 { <i>Sphenopoterium compressus</i> , M. & W.....																Central Mo.
2 " <i>cuneatus</i> , M. & W.....																Jefferson Co.
1 <i>Receptaculites Oweni</i> , Hall.....																St. Louis Co.

SUB-KINGDOM RADIATA.

1. CLASS — POLYPT.

A. ORDER ZOANTHARIA.

1 FAMILY CYATHOPHYLLIDÆ.—*Acerularia*, *Campophyllum*, *Cyathophyllum*, *Lithostrotion*, *Streptelasma*, *Zaphrentis*, *Chonophyllum*.

2 FAMILY CYATHAXONIDÆ.—*Cyathaxonla*.

3 FAMILY FAVOSITIDÆ.—*Alveolites*, *Chetetes*, *Favosites*, *Michelinia*.

4 FAMILY HALYSITIDÆ.—*Syringopora*.

B. ORDER ALCYONARIA.

5 FAMILY ALCYONIDÆ.—*Aulopora*.

6 FAMILY GRAPTOLITIDÆ.—*Plumalina*.

[illegible]

1. CLASS — CRINOIDEA.

1. **FAMILY CYATHOCRINIDÆ.** — *Agassizocrinus*, *Barycrinus*, *Cyathocrinus*, *Dichocrinus*, *Eupachyrinus*, *Forbesiocrinus*, *Onychocrinus*, *Platycrinus*, *Poteriocrinus*, *Scaphiocrinus*, *Synbathocrinus*, *Zeacrinus*, *Glyptocrinus*.
2. **FAMILY ACTINOCRINIDÆ.** — *Actinoocrinus*, *Agaricocrinus*, *Batocrinus*, *Dorycrinus*, *Strotocrinus*.

[illegible]

[illegible]

NAME.	LOWER SILURIAN.			UPPER SILUR.		DEVONIAN.			SUB-CARBONIFEROUS.					LOCALITY.				
	Magnesian L. S. Series.			Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S. S.)	Burlington.	Keokuk.	Warsaw.		St. Louis.	Chester.	COAL MEASURES.	PERMIAN.
Pentremites obliquatus, Roemer																		Cooper Co.
" Wortheni, Hall.																		"
" bipyramidalis, Hall.																		"
Archæodictaris aculeatus, Shumard.																		Jackson Co.
" biangulatus, Shumard.																		Lafayette Co.
" Keokuk, Hall.																		Clark Co.
" megastylus, Shumard.																		Jackson & St. Louis Co.
" mucronatus, M. & W.																		Andrew Co.
" Norwood, Hall.																		St. Louis Co.
" Newberry, Hambach.																		"
" Shumardana, Hall.																		"
" Wortheni, Hall.																		"
" Melonites crassus, Hambach.																		"
" Irregularis, Hambach.																		"
" multipora, Owen & Nor.																		"
" Oligoporus parvus, Hambach.																		"
" Danae, M. & W.																		"
																		Jasper Co.

3. Class — ECHINOIDEA.

1 FAMILY PALÆCHINIDÆ. — Melonites, Oligoporus.

2 FAMILY ARCHÆODICTARIDÆ.

3. CLASS — ECHINOIDEA.

1 FAMILY PALÆCHINIDÆ. — Melonites, Oligoporus.

2 FAMILY ARCHÆOCIDARIDÆ.

1. CLASS — ANNELIDA.

NAME.	LOCALITY.												Pike Co. " " "	
	LOWER SILURIAN.			UPPER SILURIAN.		DEVONIAN.		SUB-CARBONIFEROUS.			COAL MEASURES.			PERMIAN.
Coronulites carbonarius, Gurley	Magnesian L. S. Series,	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Ry. Sh.)	Nagata Gr.	Lower Helderberg.	Oriskany S. S.	Hamilton Gr.	Chemung Gr. (Choteau L. S. & Verm. S.S.)	Burlington.	Keokuk.	Warsaw	St. Louis.	Chester.	
Spirorbis kinderhookensis, Gurley														

2. CLASS — BRYOZOA.

- 1 FAMILY RHETPORIDÆ. — Archimedes, Evacinopora, Fenestella, Fenestralla.
2 FAMILY ESCHARIDÆ. — Coscinum, Pilodictya.
3 FAMILY TUBULIPORIDÆ. — Cycloporea.

[illegible]

- 1 FAMILY CRANIDÆ. — Crania.
- 2 FAMILY DISCIDINÆ. — Discina.
- 3 FAMILY KONINKIUDÆ Koninckia.
- 4 FAMILY LINGULIDÆ. Lingula.
- 5 FAMILY ORTHIDÆ. Meekella, Orthis, Orthisina.
- 6 FAMILY PENTAMERIDÆ. Camarophoria, Pentamerus.
- 7 FAMILY PRODUCTIDÆ — Chonetes, Productella, Productus.
- 8 FAMILY RHYNCHONELLIDÆ. Rhynchonella.
- 9 FAMILY SPIRIFERIDÆ Athyris, Cyrtina, Retzia, Spirifer, Syntretasma, Zygospira.
- 10 FAMILY STROPHOMENIDÆ. Leptæna, Streptorhynchus, Strophodonta, Strophomena, Hemipronites.
- 11 FAMILY TEREBRATULIDÆ. — Terebratula.

[illegible]

9	<i>Atrypa affinis</i> , Hall	St. Louis Co.
9	" <i>reticularis</i> , Linne.	Pettis Co.
9	<i>Camerothoria Wortheni</i> , Hall	Cooper Co.
7	<i>Chonetes granulifer</i> , Owen	Lafayette Co.
7	" <i>logani</i> , Norwood & Pratt	Marion Co.
7	" <i>mesoloba</i> , Norwood & Pratt	St. Louis Co.
7	" <i>ornata</i> , Shumard	Pettis Co.
7	" <i>parva</i> , Shumard	St. Louis Co.
7	" <i>Smithi</i> , Norwood & Pratt	Holt Co.
7	" <i>Shumardiana</i> , De Koninck	Marion Co.
7	" <i>Verneuilliana</i> , Norwood & Pratt	Lafayette Co.
7	" <i>Flemingi</i> , Norwood & Pratt	Holt Co.
1	<i>Orania Rowleyi</i> , Gurley	Pike Co.
9	<i>Cyrtina acutirostris</i> , Shumard	Marion Co.
9	" <i>missouriensis</i> , Shumard	Callaway Co.
9	" <i>occidentalis</i> , Swallow	Lafayette Co.
2	<i>Dicelina missouriensis</i> , Shumard	Ray Co.
2	" <i>nitida</i> , Phillips	Lafayette Co.
2	" <i>convexa</i> , Shumard	Ray Co.
10	<i>Hemipronites crassus</i> , Meek & Hayden	Lafayette Co.
3	<i>Koninkia americana</i> , Swallow	St. Louis Co.
10	<i>Leptæna mesacosta</i> , Shumard	Sage Girardeau Co.
10	" <i>sericea</i> , Sowerby	St. Louis Co.
4	<i>Lingula carbonaria</i> , Shumard	Clark Co.
4	" <i>nythoides</i> , Sowerby	St. Louis Co.
4	" <i>quadrata</i> , Eichwald	Jefferson Co.
4	" <i>umbonata</i> , Cox	Henry Co.
5	<i>Meekella striato-costata</i> , Cox	Davies Co.
5	<i>Orthis Clarkensis</i> , Swallow	Clark Co.
5	" <i>Cooperensis</i> , Swallow	Cooper & St. Louis Co.
5	" <i>Carbonaria</i> , Swallow	Lafayette Co.
5	" <i>disparilis</i> , Conrad	Jefferson Co.
5	" <i>elegantula</i> , Dalman	St. Louis Co.
5	" <i>isocosta</i> , Hall	"
5	" <i>keokuk</i> , Hall	"
5	" <i>lynx</i> , Eichwald	Clark Co.
5	" <i>micelini</i> , Hall	St. Louis Co.
5	" <i>missouriensis</i> , Shumard	Marion Co.
5	" <i>pectinella</i> , Conrad	Sage Girardeau Co.
5	" <i>resupinata</i> , Martin	St. Louis Co.
5	" <i>subquadrata</i> , Conrad	Davies Co.
5	" <i>subquadrata</i> , Hall	Jefferson Co.
5	" <i>tricenaria</i> , Conrad	St. Louis Co.
5	" <i>testudinaria</i> , Dalman	"
5	<i>Orthisina occidentalis</i> , Swallow	"
5	<i>Pentamerus robusta</i> , Hall	Caldwell Co.
5	<i>Pentamerus salicensis</i> , Swallow	Jasper Co.
7	<i>Productus arcuatus</i> , Hall	Monteau Co.
7	" <i>equicostatus</i> , Shumard	Cooper Co.
7	" <i>americanus</i> , Swallow	Jackson Co.
7	" <i>iserialis</i> , Hall	St. Louis Co.
7	" <i>boonensis</i> , Swallow	Henry Co.
7	" <i>costatus</i> , Sowerby	Cooper Co.
7	" <i>cora</i> , D'Orbigny	Boone Co.
7	" <i>callawayensis</i> , Swallow	Jackson & St. Louis Co.
7	" <i>cooperensis</i> , Swallow	Callaway Co.
7	" <i>concentrica</i> , Hall	Cooper Co.
7	" <i>crenolata</i> , Shumard	"
7	" <i>depressus</i> , Swallow	St. Louis Co.

9	<i>Spirifer cuspidata</i> , Sowerby.....	Cooper Co.
9	" <i>cooperensis</i> , Swallow.....	Jasper Co.
9	" <i>Forbesi</i> , Norw. & Pratt.....	Morgan Co.
9	" <i>grimesi</i> , Hall.....	Marion Co.
9	" <i>hannibalensis</i> , Swallow.....	St. Louis Co.
9	" <i>increscens</i> , Hall.....	Davies Co.
9	" <i>Kentuckiensis</i> , Shumard.....	Clark Co.
9	" <i>lavigata</i> , Swallow.....	Cooper Co.
9	" <i>laticostatus</i> , Hall.....	Jasper Co.
9	" <i>lineatoides</i> , Swallow.....	Morgan Co.
9	" <i>Leidyi</i> , Norwood & Peat.....	St. Louis Co.
9	" <i>lineatus</i> , Swallow.....	"
9	" <i>Littoni</i> , Hall.....	"
9	" <i>Logani</i> , Hall.....	Morgan Co.
9	" <i>marionensis</i> , Shumard.....	Marion Co.
9	" <i>Meeki</i> , Swallow.....	Pettis Co.
9	" <i>missouriensis</i> , Swallow.....	Boone Co.
9	" <i>mucronata</i> , Conrad.....	St. Louis Co.
9	" <i>osagensis</i> , Swallow.....	Pettis Co.
9	" <i>Owenti</i> , Hall.....	"
9	" <i>planiconvexa</i> , Shumard.....	St. Louis Co.
9	" <i>peculiaris</i> , Shumard.....	Cooper Co.
9	" <i>plena</i> , Hall.....	Jasper Co.
9	" <i>spirosa</i> , Hall.....	St. Louis Co.
9	" <i>striata</i> , Martin.....	Jasper Co.
9	" <i>subaequalis</i> , Hall.....	"
9	" <i>subcardiformis</i> , Hall.....	Pettis Co.
9	" <i>subrotundata</i> , Hall.....	Taney Co.
9	" <i>Taneyensis</i> , Swallow.....	Jasper Co.
9	" <i>tenuicostatus</i> , Hall.....	St. Marys, Mo.
9	" <i>translatus</i> , Hall.....	Taney Co.
9	" <i>vernionensis</i> , Hall.....	St. Louis Co.
10	<i>Streptorhynchus planumbona</i> , Hall.....	Callaway Co.
10	<i>Strophodonta altidorsata</i> , Swallow.....	"
10	" <i>aquicostata</i> , Swallow.....	"
10	" <i>boonensis</i> , Swallow.....	"
10	" <i>callawavensis</i> , Swallow.....	"
10	" <i>cymbiformis</i> , Swallow.....	"
10	" <i>infexa</i> , Swallow.....	"
10	" <i>Kemperi</i> , Swallow.....	"
10	" <i>navalis</i> , Swallow.....	"
10	" <i>subcymbiformis</i> , Swallow.....	"
10	" <i>quadrata</i> , Swallow.....	"
10	<i>Strophomena alternata</i> , Conrad.....	St. Louis Co.
10	" <i>deltoides</i> , Conrad.....	"
10	" <i>depressa</i> , Sowerby.....	"
10	" <i>flitexta</i> , Hall.....	"
9	<i>Syntrileasma hemiplicata</i> , Hall.....	Jackson Co.
11	<i>Terebratulina arcuata</i> , Swallow.....	St. Genevieve Co.
11	" <i>brevilobata</i> , Swallow.....	Jasper Co.
11	" <i>formosa</i> , Hall.....	St. Marys, Mo.
11	" <i>gracilis</i> , Swallow.....	Jasper Co.
11	" <i>parva</i> , Swallow.....	Cooper Co.
11	" <i>turgida</i> , Hall.....	St. Louis Co.
9	<i>Zygospira modesta</i> , Say.....	"

II FAMILY COXCLARDE. — Comalera.

[illegible]

6. CLASS — LAMELLIBRANCHIATA.

[illegible]

1	<i>Allotrama granosa</i> , Shumard.					Clay Co.
2	" <i>nannibalensis</i> , Shumard					Marion Co.
3	" <i>lata</i> , Swallow.					Lafayette Co.
4	" <i>marionensis</i> , White.					St. Louis Co.
5	" <i>clavata</i> , McChesney.					St. Genevieve Co.
6	" <i>terminalis</i> , Hall.					Jackson Co.
7	<i>Astartella vera</i> , Hall.					Lafayette Co.
8	<i>Avicula circulus</i> , Shumard.					Monticau Co.
9	" <i>cooperensis</i> , Shumard.					Cooper Co.
10	" <i>magna</i> , Swallow					Knox Co.
11	" <i>pinniformis</i> , Geinitz.					Jackson Co.
12	<i>Aviculopecten carboniferus</i> , Stevens.					Jasper Co.
13	" <i>burlingtonensis</i> , M. & W.					Jackson Co.
14	" <i>Konincki</i> , M. & W.					St. Louis Co.
15	" <i>Coreyanus</i> , White					Jackson Co.
16	" <i>Coxanus</i> , M. & W.					Cooper Co.
17	<i>Cardinia occidentalis</i> , Swallow					Lafayette Co.
18	<i>Cardiomorpha missouriensis</i> , Shumard.					Cooper Co.
19	" <i>triangularis</i> , Swallow					St. Louis Co.
20	" <i>vetusta</i> , Hall.					Lafayette Co.
21	<i>Cardium lexingtonensis</i> , Swallow					Andrew Co.
22	<i>Chaenomya</i> , Cooper, M. & H.					Cooper Co.
23	<i>Chaenomya minnehaha</i> , Swallow.					Harrison Co.
24	<i>Cypriocardia chouteauensis</i> , Swallow					Cooper Co.
25	" <i>occidentalis</i> , Swallow.					Pike Co.
26	" <i>plicatula</i> , Swallow.					Platte Co.
27	" <i>Shumardana</i> , Swallow					St. Genevieve Co.
28	" <i>Wheeleri</i> , Swallow					Caldwell Co.
29	<i>Clidophorus solenoides</i> , Geinitz.					Jackson Co.
30	<i>Edmondia aspenwallensis</i> , Meek					Davis Co.
31	" <i>marionensis</i> , Swallow					Cooper Co.
32	" <i>subtruncata</i> , Meek					Platte Co.
33	<i>Isocardia curta</i> , Shumard					Cooper Co.
34	<i>Leda bellastrata</i> , Stevens.					Cooper Co.
35	<i>Leptodomus arata</i> , Hall					Gentry Co.
36	<i>Lima retifera</i> , Shumard					St. Louis Co.
37	<i>Lithophaga pertenuis</i> , Meek & Worthen					Gentry Co.
38	<i>Macrodont tenuistriata</i> , Meek & Worthen.					St. Louis Co.
39	<i>Monopteria gibbosa</i> , Meek & Worthen.					Platte Co.
40	" <i>longispina</i> , Cox					Jackson Co.
41	<i>Monotis gregaria</i> , Meek & Worthen.					Henry Co.
42	<i>Myalina subquadrata</i> , Shumard					Jackson Co.
43	" <i>concentrica</i> , Meek & Worthen					Platte Co.
44	" <i>angulata</i> , Meek & Worthen					Cooper Co.
45	" <i>recurvirostris</i> , Meek & Worthen.					Clay Co.
46	<i>Mytilarca occidentalis</i> , White & Whitfield.					Cooper Co.
47	<i>Nucula ventricosa</i> , Hall.					Gentry Co.
48	<i>Pecten missouriensis</i> , Shumard.					St. Louis Co.
49	" <i>Broadhead</i> , Swallow.					Lafayette Co.
50	" <i>Hawni</i> , Geinitz.					Jackson Co.
51	<i>Pinna missouriensis</i> , Swallow					St. Genevieve Co.
52	<i>Pleurophorus oblongus</i> , Meek.					Henry Co.
53	<i>Pleurophorus occidentalis</i> , M. & H.					Henry Co.
54	<i>Sanguinolites missouriensis</i> , Swallow					Pike Co.
55	" <i>rigidus</i> , White & Whit					Cooper Co.
56	<i>Schizodus amplius</i> , Meek & Worthen					Platte Co.
57	" <i>perelegans</i> , Meek & Worthen					"
58	" <i>Wheeleri</i> , Swallow					"
59	<i>Tellinomya protensa</i> , Hall					Jackson Co.

- 1 FAMILY BELLEROPHONTIDÆ. — Bellerophon, Bucania.
- 2 " CALYPTERIDÆ. — Platyçéras.
- 3 " DENTALIDÆ. — Dentalium.
- 4 " HALICIDÆ. — Streptaxis.
- 5 " MACLUREIDÆ. — Maclurea.
- 6 " NATICIDÆ. — Naticopsis, Littorina.
- 7 " PLEUROTOMARIDÆ. — Murchisonia, Pleurotomaria, Raphistoma.
- 8 " PYRAMIDELLIDÆ. — Chemnitzia, Loxonema, Macrochellus, Bullimorpha, Polyphemopsis, Soleniscus, Subulites.
- 9 " SOLARIDÆ. — Euomphalus, Platyostoma, Steaparollus.
- 0 " TURBINIDÆ. — Cyclonema, Holoepa.
- 0 " PATELLIDÆ. — Lepetopsis.

	NAME.	LOWER SILURIAN.	UPPER SILUR.	DEVONIAN.	SUB-CARBONIFEROUS.	LOCALITY.
1	Bellerophon bilobatus, Sowerby.	Magnesian L. S. Series.	Trenton L. S.	Hudson Riv. Gr. (Recep. L. S. & Hud. Riv. Sh.)	Niagara Gr.	Lower Helderberg.
1	" carbonarius, Cox.					
1	" crassus, Meek & Worthen.					
1	" ellipticus, McCheaney.					
1	" Meekianus, Swallow.					
1	" missouriensis, Swallow.					
1	" monfortianus, Norwood & P.					
1	" nodocarinatus, Hall.					
1	" percarinatus, Conrad.					
1	" stevensanus, McCheaney.					
1	" textiliformis, Gurley.					
1	" Blaneyanus, McCheaney.					
1	" sublevis, Hall.					
1	" Bucania expansa, Hall.					
8	Bulimorpha bulmiformis, Hall.					
8	Chemnitzia tenuilineata, Shumard.					
10	Cyclonema leavenworthiana, Hall.					
3	Dentalium missourienae, Swallow.					
9	Ecnomphalus boonenae, Swallow.					
9	" catilloides, Conrad.					

9	Eumphalus latus, Hall				Jasper Co.
0	" rugosus, Hall				Henry Co.
0	" spargensis, Hall				Cooper Co.
10	Holopea obliqua, Hall				St. Louis Co.
11	Lepeopsis Partisia, Gurley				Jackson Co.
6	Litorina Wheeleri, Swallow				Monroe Co.
8	Loxoneura rugosum, Meek & Worthen				St. Louis Co.
8	Macclurea magna, Le Sueur				" "
8	Macrocheilus cooperensis, Swallow				Cooper Co.
8	" fusiformis, Hall				Holt Co.
8	" missouriensis, Swallow				Howard Co.
8	" media ls, Meek & Worthen				Charlton Co.
8	" newberryi, Stevens				Holt Co.
8	" ponderosus, Swallow				Howard Co.
8	" primigenius, Conrad				Charlton Co.
8	" texanus, Shumard				Holt Co.
7	" ventricosus, Hall				Sullivan Co.
7	Murchisonia archimedeae, McChesney				" "
7	" bellicincta, Hall				St. Louis Co.
7	" bicincta, Hall				" "
7	" carinifera, Shumard				" "
7	" gracilis, Hall				Franklin Co.
7	" melaniliformis, Shumard				Ozark Co.
7	" ozarkensis, Shumard				Holt Co.
7	" terebra, White				Jefferson Co.
7	" vittata, Hall				Henry Co.
7	Naticopsis altoonensis, McChesney				St. Genevieve.
6	" cheslerensis, Swallow				Cass Co.
6	" monilifera, White				Sullivan Co.
6	" nana, Meek & Worthen				Henry Co.
6	" nodosus, Meek & Worthen				Roane Co.
6	" Pricei, Shumard				Henry Co.
6	" ventricosus, Meek & Worthen				" "
6	" Wheeleri, Swallow				Lafayette Co.
6	Shumardi, McChesney				Fettis Co.
6	Platyceeras biserialis, Hall				Cooper Co.
2	" acutirostris, Hall				Jasper Co.
2	" equilateralis, Hall				Cooper Co.
2	" tribulosum, White				" "
2	Pleurostoma peoriense, McChesney				Jackson Co.
3	Pleurotomaria carbonatara, Norwood & Peat				" "
3	" Broadheadi, White				St. Louis Co.
3	" lenticularis, Emmons				Jackson Co.
3	" missonienalis, Swallow				Henry Co.
3	" speciosa, Meek & Worthen...				Jackson Co.
3	" perhumerosa, Meek				Sullivan Co.
3	" sphaerulata, Conrad				St. Louis Co.
3	" subtilistriata, Hall				" "
3	" subdepressa, Gemiz				Jackson Co.
3	" subobovatus, Meek & Worthen...				" "
3	" tabulata, Hall				Cooper Co.
3	" trochiformis, Swallow				Jackson Co.
3	" turbidiformis, Meek & Worthen.				" "
3	" umbilicata, Hall				Cooper Co.
3	" Polyphemopsis nitida, Meek & Worthen...				Jackson Co.
3	" peracuta, Meek & Worthen...				St. Louis Co.
3	" Raphistoma subplana, Shumard				Holt Co.
3	" Soleniscus planus, White				Ozark Co.
3	" Straparollus lens, Hall				Holt Co.
3	" planidorstatas, Meek & Worthen				Cooper Co.
3					St. Genevieve

SUB-KINGDOM ARTICULATA.

1. CLASS — CRUSTACEA.

- | | |
|---|--|
| 1 | FAMILY ACIDASPIDÆ. — Acidaspis. |
| 2 | “ ASAPHIDÆ. — Asaphus, Illaenus. |
| 3 | “ CALYMENIDÆ. Calymene. |
| 4 | “ CERAURIDÆ Ceraurus, Enclonurus. |
| 5 | “ CYTHASPIDÆ. Cyphas. |
| 6 | “ CYTHERIDÆ. — Cythere. |
| 7 | “ PHACOPIDÆ. — Phacops, Dalmanites. |
| 8 | “ PRETIDÆ. — Grifflibides, Prætus, Phillipsia. |

[illegible]

ORDER GANOIDI.

NAME.	LOCALITY.
Amacanthus gibbosus, Newberry & W.	St. Louis Co.
Asperoprychius St. Ladoviel, St. John & W.	" "
Aspidolus crenulatus, N. & W.	St. Francisville, Mo.
Balaacanthus baculiformis, St. John & W.	St. Louis Co.
Cladodus eccentricus, St. John & W.	" "
" elegans, Newberry & Worthen.	" "
" ferox, Newberry & Worthen.	" "
" ischypus, Newberry & Worthen.	" "
" euglypheus, St. John & W.	" "
" spinosus, Newberry & Worthen.	" "
Chomatodus incrassatus, St. John & W.	" "
" parallelus, St. John & W.	Cooper Co.
Cochliodus obliquus, St. John & W.	St. Louis Co.
" Van Hornii, St. John & W.	" "
Copodus Van Hornii, St. John & W.	" "
Ctenacanthus costatus, Newberry & W.	" "
" excavatus, St. John & W.	" "
" gracillimus, Newberry & W.	Lewis Co.
" pugilunculus, St. John & W.	St. Louis Co.
Dactylodus princeps, Newberry & W.	" "
Dalodus cinctulus, St. John & W.	" "
" Lattoni, Newberry & Worthen.	" "
" parvus, St. John & Worthen.	" "
" Rhomboides, Newberry & W.	" "
Deltodapsis St. Ladoviel, St. John & W.	" "
Deltoptychilus expansus, St. John & W.	" "
" Wachsmuthi, St. John & W.	" "
Desmiodus costelliferus, St. John & W.	Cooper Co.
" flabellum, St. John & W.	Cooper Co.
" lignoniformis, St. John & W.	St. Louis Co.
Drapanacanthus reversus, St. John & W.	" "
" stellatus, N. & W.	" "
Erismacanthus McCoyanus, St. John & W.	St. Louis Co.

Gampsacanthus latus, St. John & W.	Cooper Co.
" squamosus, St. John & W.	St. Louis Co.
" typus, St. John & W.	" "
Gelsacanthus stellatus, St. John & W.	" "
Harpacodus occidentalis, St. John & W.	St. Francisville, Mo.
Helodus consolidatus, Newberry & Worthen.	St. Louis Co.
" crenulatus, Newberry & Worthen.	Cooper Co.
Homacanthus globosus, Newberry & Worthen.	Lewis Co.
Lambodus calceolus, St. John & W.	St. Louis Co.
" costatus, St. John & W.	Cooper Co.
Lecracanthus unguiculus, St. John & Worthen.	St. Louis Co.
Lisgodus curtus, St. John & Worthen.	Cooper Co.
" selluliformis, St. John & W.	St. Louis Co.
Listracanthus hystrix, Newberry & Worthen.	Andrew Co.
Leptacanthus occidentalis, Newberry & Worthen.	St. Louis Co.
Marracanthus rectus, Newberry & Worthen.	" "
Oracanthus consimilis, St. John & W.	" "
" vetustus, Leidy.	" "
Orodus plicatus, Newberry & Worthen.	" "
" variocostatus, St. John & W.	" "
Peliodus quadratus, St. John & W.	" "
Petalodus destructor, Newberry & Worthen.	Jackson Co.
" linguifer, Newberry & Worthen.	St. Louis Co.
Petalorhynchus distortus, St. John & W.	" "
" pseudosagittatus, St. John & W.	" "
Petrodus occidentalis, Newberry & Worthen.	Henry Co.
Physonemus falcatus, St. John & W.	St. Louis Co.
" parvulus, St. John & W.	Cooper Co.
Polyrhizodus Littoni, Newberry & Worthen.	St. Louis Co.
" amplius, St. John & W.	Boone Co.
" Williamsi, "	St. Louis Co.
Poecilodus vassoviensis, "	" "
Psammodus plenus, "	" "
" caelatus, "	" "
" reticulatus, "	" "
Prephodus latus, "	" "
Sandalodus crassus, Newberry & Worthen.	" "
" laevissimus, Newberry & Worthen.	" "
" spatulatus, Newberry & Worthen.	" "
Tanaodus prenanthus, St. John & Worthen.	" "
" sculptus, St. John & Worthen.	" "
Venusodus Leidy, St. John & Worthen.	" "
Vaticinodus simplex, St. John & Worthen.	St. Francisville, Mo.
Xystrodus imitatus, "	St. Louis Co.

BLUFF OR LOESS FORMATION.

SUB-KINGDOM MOLLUSCA.

<i>Name.</i>	<i>Locality.</i>
<i>Amnicola lapidaria</i> , Say.....	Near St. Louis.
<i>Helix rufa</i> , De Kay.....	St. Joseph Landing.
<i>albolabris</i> , Say.....	One-half mile below Great Nemaha.
<i>alternata</i> , Say.....	Bellevue, Lexington.
<i>concava</i> , Say.....	Near St. Louis.
<i>thyroideus</i> , Say.....	Bluff City Landing.
<i>profunda</i> , Say.....	Lexington.
<i>multilineata</i> , Say.....	Near mouth Big Nemaha and Platte River.
<i>clausa</i> , Say.....	Near mouth Big Nemaha and Platte River.
<i>striaella</i> , Anthony.....	St. Louis, Boonville.
<i>monodon</i> , Rackett.....	St. Louis.
<i>electrina</i> , Gould.....	St. Louis and Boonville.
<i>arborea</i> , Say.....	St. Louis.
<i>indentata</i> , Say.....	Below mouth of Platte River.
<i>hirsuta</i> , Say.....	Near St. Louis.
<i>lineata</i> , Say.....	Mouth of Platte River.
<i>minuta</i> , Say.....	Mouth of Platte River.
<i>labyrinthica</i> , Say.....	St. Louis.
<i>Helicina occulta</i> , Say.....	Boonville and St. Louis.
<i>Limnea fragilis</i> , Lin.....	Lexington.
" <i>reflexa</i> , Say.....	Bluff City Landing.
" <i>umbrosa</i> , Say.....	Near mouth of Nemaha.
<i>Physa plicata</i> , De Kay.....	Near mouth of Wolf River.
" <i>heterostrophæ</i> , Say.....	Mouth of Platte River.
" <i>elongata</i> , Say.....	Mouth of Platte River.
" <i>gyrinea</i> , Say.....	Below Platte River.
<i>Planorbis trivolvæ</i> , Say.....	Bluff City Landing.
" <i>armigerus</i> , Say.....	Mouth of Wolf River.
<i>Pupa armifera</i> , Say.....	Near St. Louis.
<i>Succinea obliqua</i> , Say.....	Bluff City Landing.
" <i>campestris</i> , Say.....	Bluff City Landing.
" <i>ovalis</i> , Say.....	Bluff City Landing.
<i>Valvata tricarinata</i> , Say.....	Bluff City Landing.

SUB-KINGDOM VERTEBRATA.

CLASS MAMMALIA.

<i>Names.</i>	<i>Locality.</i>
<i>Bootherium cavifrons</i> , Leidy.....	Benton Co.
<i>Mastodon giganteus</i> , Cuv.....	Pettis and St. Louis Co.
<i>Elephas primigenius</i> , Blume.....	Boone Co.
<i>Tastor fiber</i> , Ow.....	Near mouth of Big Nemaha.

VEGETABLE KINGDOM.

PLANTÆ.

1. CELLULAR CRYPTOGRAMOUS PLANTS.

2. CLASS — THALASSOPHYTES.

NAME.	Coal Meas- ures.	
Conostychus Broadheadi, Lesqx.....	_____	Vernon Co.
“ prolifer, “	_____	“ “
Taonurus Colletti, “	_____	Henry Co.

2. VASCULAR CRYPTOGRAMOUS PLANTS.

ACROGENS.

3. CLASS — EUISETACEÆ.

NAME.	Coal Meas- ures.	
<i>Order 1. Calamariæ.</i>		
Annularia angustifolia, Lesqx.....	_____	Henry Co.
“ longifolia, Brgt.....	_____	“ “
“ sphenophylloides, Lenk & Gutb.....	_____	“ “
Asterophyllites fasciculatus, Lesqx.....	_____	“ “
“ rigidus, Brgt.....	_____	“ “
Calamites cistii, “	_____	“ “
“ Suckowii “	_____	“ “
Sphenophyllum erosum, Ll. & Hutt.....	_____	“ “
“ filiculme, Lesqx.....	_____	“ “
“ longifolium, Germ.....	_____	“ “
“ oblongifolium, “	_____	“ “
“ Schlotheimi, Brgt.....	_____	“ “
4. CLASS — FILICACEÆ (Ferns.)		
<i>Order 1. Neuropterids.</i>		
Neuropteris angustifolia, Brgt	_____	Henry Co.
“ cordata, “	_____	“ “
“ dilatata, Ll. & Hutt.....	_____	“ “
“ fimbriata, Lesqx.....	_____	Jasper Co.
“ flexuosa, Brgt.....	_____	Henry Co.
“ hirsuta, Lesqx.....	_____	“ “
“ Loshi, Brgt.....	_____	“ “
“ missouriensis, Lesqx.....	_____	“ “
“ rarinervis, Buby.....	_____	“ “
“ tenuifolia, Brgt.....	_____	“ “
Odontopteris heterophylla, Lesqx.....	_____	“ “
“ sphenopteroides, “	_____	“ “
“ subcrenulata, “	_____	“ “
Dictyopteris obliqua, Buby.....	_____	“ “

NAME.	Coal Meas- ures.	
<i>Order 2. Alethopterids.</i>		
<i>Alethopteris ambigua</i> , Lesqx.....	Henry Co.	
“ <i>lonchitica</i> , Schloth.....	“ “	
“ <i>serlii</i> , Brgt.	“ “	
<i>Callipteridium membranaceum</i> , Lesqx.....	“ “	
“ <i>Owenii</i> , “	“ “	
“ <i>Sullivantii</i> , “	“ “	
<i>Order 3. Pseudopecopterids.</i>		
<i>Pseudopecopteris acuta</i> , Brgt.	Henry Co.	
“ <i>irregularis</i> , St.....	“ “	
“ <i>macilentia</i> , Ll & Hutt	“ “	
“ <i>nummularia</i>	“ “	
“ <i>obtusiloba</i>	“ “	
“ <i>Sillimanni</i> , Brgt.....	“ “	
<i>Order 4. Pecopterids.</i>		
<i>Pecopteris arborescens</i> , Brgt.....	Henry Co.	
“ <i>clintoni</i> , Lesqx.....	“ “	
“ <i>cristata</i> , Gutb.....	“ “	
“ <i>dentata</i> , Brgt.....	“ “	
“ <i>erosa</i> , Gutb	“ “	
“ <i>pennaeformis</i> , Brgt.....	“ “	
“ <i>vestita</i> , Lesqx.....	“ “	
<i>Order 5. Sphenopterids.</i>		
<i>Sphenopteris Brittii</i> , Lesqx.	Henry Co.	
“ <i>chærophylloides</i> , St.....	“ “	
“ <i>crystata</i> , St.....	“ “	
“ <i>dubuissoni</i> , Brgt.....	“ “	
“ <i>furcata</i> , “	“ “	
“ <i>Gravenhorsti</i> “	“ “	
“ <i>mixta</i> , Schp	“ “	
“ <i>spinosa</i> , Göpp.....	“ “	
“ <i>splendens</i> , Lesqx.....	“ “	
“ <i>tridactylites</i> , Brgt.....	“ “	
<i>Eremopteris missouriensis</i> , Lesqx.....	“ “	
<i>Ferns of uncertain attribution.</i>		
<i>Rhacophyllum adnascens</i> , Ll. & Hutt	Henry Co.	
“ <i>arborescens</i> , Lesqx.....	“ “	
“ <i>filiciforme</i> Schp.....	“ “	
“ <i>fimbriatum</i> , Lesqx.....	“ “	
“ <i>hamulosum</i> , “	“ “	
“ <i>hirsutum</i> , “	“ “	
“ <i>lactuca</i> , St.....	“ “	

NAME.	Coal Meas- ures.	
<i>Ferns of uncertain attribution (continued).</i>		
Rhacophyllum membranaceum, Lesqx.....	_____	Henry Co.
" spinosum, "	_____	" "
Soroeladus ophioglossoides, "	_____	" "
Megaphyllum Goldenbergii, Weiss.....	_____	" "
5. CLASS — LYCOPODIACEÆ.		
Lepidodendron aculeatum, St.....	_____	Vernon Co.
" Brittsli, Lesqx.....	_____	Henry Co.
" cyclostigma, "	_____	" "
" lanceolatum "	_____	" "
" marginatum, "	_____	" "
" Sternbergi, Ll. & Hutt.....	_____	" "
Lepidophloios dilatatus Lesqx.....	_____	" "
" sigillarioides, Lesqx.....	_____	" "
Lepidophyllum majus, Brgt..	_____	" "
" minus, Lesqx.....	_____	" "
Lepidostrobos Goldenbergii, Schp.....	_____	" "
<i>Order Sigillariæ.</i>		
Sigillaria fissa, Lesqx.....	_____	Henry Co.
" menardi, "	_____	" "
" reniformis, Brgt..	_____	" "
" sculpta, Lesqx.....	_____	" "
" spinulosa, Germ.....	_____	" "
Pinnularia capillacea, Lesqx	_____	" "
6. CLASS — CORDAITÆ.		
Cordalanthus dichotomus, Lesqx.....	_____	Henry Co.
" gemmifer, "	_____	" "
Cordaites communis, "	_____	" "
" diversifolius, "	_____	" "
Desmiophyllum gracile "	_____	Jasper Co.
Lepidoxylon anomalum "	_____	Henry Co.
Trigonocarpus Dawsonii, Ll. & Hutt ...	_____	Cedar Co.
" olivæformis, Ll. & Hutt	_____	" "

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and the role of the accounting department in ensuring the integrity of the financial statements.

2. It also highlights the need for regular audits and the importance of transparency in financial reporting.

3. The second part of the document outlines the various methods used to collect and analyze financial data, including the use of spreadsheets and specialized software.

4. It also discusses the challenges faced by the accounting department in managing large volumes of data and the need for automation.

5. The third part of the document focuses on the importance of communication and collaboration between the accounting department and other departments within the organization.

6. It also discusses the role of the accounting department in providing financial advice and support to management.

7. The fourth part of the document discusses the importance of staying up-to-date with the latest accounting standards and regulations.

8. It also discusses the need for continuous professional development and the importance of maintaining high ethical standards.

9. The fifth part of the document discusses the importance of maintaining accurate records of all transactions and the role of the accounting department in ensuring the integrity of the financial statements.

10. It also highlights the need for regular audits and the importance of transparency in financial reporting.

*Compliments of
G. C. R. 200*

GEOLOGICAL SURVEY OF MISSOURI.
ARTHUR WINSLOW, STATE GEOLOGIST.

J. E. Harrison

BULLETIN NO. 2.

A BIBLIOGRAPHY

OF THE

GEOLOGY OF MISSOURI

BY

F. A. SAMSON.

PUBLISHED BY
THE GEOLOGICAL SURVEY.

JEFFERSON CITY,
MISSOURI, 1880.

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*Compliment of
G. C. Anshutz*

GEOLOGICAL SURVEY OF MISSOURI.
ARTHUR WINSLOW, STATE GEOLOGIST.

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December, 1880.



J. S. Damm

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GEOLOGY OF MISSOURI

BY

F. A. SAMPSON.

JEFFERSON CITY, MO.:
TRIBUNE PRINTING COMPANY, STATE PRINTERS AND BINDERS.
1890.

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STATE GEOLOGIST

ARTHUR WINSLOW.....JEFFERSON CITY

(111)

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C. F. MARBUT, assistant.

JOHN C. HALLIGAN, clerk.

PREFACE.

With a broad foundation of knowledge should we build our monuments; past experience is the best guide to future practice; progress demands in the product of to-day an increment to the product of yesterday. From these three points of view must we regard as valuable the work which is here presented. A bibliography directs specifically to many sources of information, it leads to a knowledge of the outcome of others' efforts, it prevents duplication of labors and guides operations into productive channels.

The amount of work and time necessary for the compilation of such a volume of reference often deters from its preparation; titles have to be gathered from time to time as opportunity presents itself, many libraries in many places have to be visited, old book stores must be frequented and many a dusty book pile from chest, from top shelf, from garret, from cellar, must be overhauled and studied. Hence the Survey is fortunate in having donated to it, through the generosity of Mr. Sampson, the manuscript for this publication. It is the product of work persistently, though intermittently, carried on during several years; and the scope of the references and the amount of the material presented all testify to the studious zeal which sustained this work.

Over eight hundred titles of publications containing matter relating directly to the subject of the Geology of Missouri, will seem an astounding number to many. They are, however, not all independent works, and they vary much in the extent of their reference to the subject and in the qualities of originality and intrinsic value. In some cases, the nature and the extent of the reference is indicated in an accompanying note, elsewhere it can be conjectured from the title, while the relative merit of each can be judged of through a consideration of the nature and source of the publication and of the character and standing of the author.

With reference to the origin, as well as to character, these publications may be classed as follows :

1. **PRODUCTS OF ORIGINAL INVESTIGATION**
 - a. *With entire reference to Missouri.*
 - b. *With partial reference to Missouri.*
 2. **COMPILATIONS FROM PUBLICATIONS OF ORIGINAL INVESTIGATION.**
 3. **INCIDENTAL OR DEPENDENT PUBLICATIONS.**
- 1a. As products of original investigation with entire reference to Missouri, we would include, among the titles given, all of the reports of Missouri Geological Surveys, of the State Board of Internal Improvements, of the Bureau of Statistics and of the Smithsonian Institution; and we would further include a portion of the papers contained in the Annual Reports of the State University, in the reports of the State Board of Agriculture, in the United States Agricultural Reports, a portion of the papers of scientific societies and periodicals, and of the miscellaneous and mineral water publications, the total number under the heading being..... 206 titles
 - 1b. As products of original investigation, with only partial reference to Missouri, we would include all mentioned publications of the United States Geological Survey, a portion of the articles included among the reports of the United States Census, among the American State Papers, among the Miscellaneous Documents of Congress, among the United States Agricultural reports, among the reports of other State Surveys and among the papers of scientific societies and periodicals and miscellaneous publications, in all 286 titles
 2. Among compilations we would include the publications issued by the State Board of Immigration, a portion of the papers included in the reports of the State Board of Agriculture, in the Census reports, in the Miscellaneous Documents of Congress, and some of the papers published by scientific societies and in periodicals, a number of the miscellaneous publications and some of those relating to mineral waters, giving a total of..... 162 titles
 3. As incidental publications we would class Governors' addresses and messages, reports of Legislative committees and memorials to the Legislature, and also a portion of the papers contained in the Annual Reports of the State University, in the reports of the State Board of Agriculture, in the American State Papers, and among the Miscellaneous Documents of Congress, also the reviews and editorials among the publications of societies and periodicals, and a portion of the Miscellaneous titles. The total under this heading would thus be... 167 titles

Of publications of the State of Missouri there are 144 titles, of publications of the United States Government there are 65 titles, of publications of other State Surveys there are 13 titles, while of Miscellaneous publications there are 579 titles, more than twice as many as in all other classes together.

It would be interesting to enter into a more careful analysis of the contents of all these different publications, to separate the grain from the chaff, to distinguish between what is fundamental and what is out-

growth or superstructure. Many publications are products of others, some are repetitions, others with similar titles mark successive stages of knowledge; some are profound, rich in suggestion and of great educational value; others are superficial and barren. Neither the time available nor the means of access to these publications will, however, permit this, and such classification must be left to the individual. Pre-eminently as fundamental and educational, however, we must recognize the official and professional reports of State or National governments; the mass of information which these contain, presented officially and authoritatively, finds outlet and becomes disseminated through many channels. Some of the pamphlets, whose titles are given here, are but reproductions of portions of such reports popularized for special ends; others teem with extracts from or references to such official reports; while the daily or weekly issues of the Press, which are not catalogued here, distribute to the great mass of the people those results which can be turned to immediate use.

Beyond illustrating, however, the manner in which the results of such work become diffused, this list of publications is valuable historically as an index to the progress of knowledge concerning this special subject, and also as a measure of the interest and activity exhibited in the pursuit of such knowledge. The dates of the publications whose titles are given range from the year 1804 to the year 1890; during this interval they are distributed as follows:

Between the years 1801 and 1810.....	3	were published.
“ “ 1811 “ 1820.....	7	“ “
“ “ 1821 “ 1830.....	27	“ “
“ “ 1831 “ 1840.....	33	“ “
“ “ 1841 “ 1850.....	74	“ “
“ “ 1851 “ 1860.....	126	“ “
“ “ 1861 “ 1870.....	124	“ “
“ “ 1871 “ 1880.....	204	“ “
“ “ 1881 “ 1890.....	203	“ “

At the beginning of this century, according to this record, the subject of the geology of Missouri attracted little public notice. It then received meagre attention for a period of forty years, and it was not until after the year 1840 that the importance of the subject became appreciated and that active interest was developed. From that time on this interest has apparently been vigorous and continuous. The results of the future will prove the value of this publication in nourishing this growth by guiding such interest into the most productive lines of work.

ARTHUR WINSLOW,
State Geologist.

Jefferson City, Dec. 16, 1890.

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INTRODUCTION.

The following bibliography of the geology, palæontology and mineralogy of the State of Missouri, commenced for the purpose of systematically adding to the author's library, has developed into a much larger number of titles than was at first thought to be possible, and still it is far from being complete. References to many books and papers not here included have been made, but the titles obtained have not been full enough for their insertion here.

The list of Missouri publications published since 1836 is nearly complete, almost all of the publications of the different departments of the State having been examined. Whatever may have been printed in the Journals of the first seven General Assemblies is not included, all efforts to see copies of any one of them having failed.

The transactions and journals of the scientific societies have all been examined, but, of a few, complete sets were not seen, and some papers have thus, probably, been omitted.

It will no doubt be noticed with surprise that so many Missouri fossils have been described in the publications of the Geological Surveys of other States, Illinois and Pennsylvania especially furnishing long lists. It has been the intention to give lists of all fossils for which the State of Missouri furnished the type specimens, the species being given in a note following the title of the paper in which the descriptions were contained. These lists give, in addition to the name of the species, the number of the page, plate and figure of the report in which they are described, and the geological formation and the locality in which each specimen was found. The name and formation are given as stated in the papers, and no effort is made to reduce the nomenclature to that which is at present recognized, or to correct mistakes.

For convenience of reference the titles are numbered. The first paragraph is a copy of the title, and any remarks in reference to the contents follow in a paragraph in smaller type.

In the arrangement of titles the alphabetical order has been adopted partly, and the chronological partly. The publications of the State Sur-

vey are given on the latter plan; so the Messages of the Governors of the State, and part of the other State documents. In other cases the papers from each different publication are arranged alphabetically, while the index combines all of the papers in one alphabetical list.

I am under obligations to the librarians or owners of the following libraries for access to them: Columbia College, New York City; Academy of Science, New York City; St. Louis Academy of Science; Kansas Academy of Science, Topeka; Cornell University, Ithaca, N. Y.; Public School, including the Shumard Library, St. Louis; Kansas State Historical Society, Topeka; School of Mines, Rolla, Mo.; Missouri State, Jefferson City; Geological Survey, Jefferson City; Lieut. A. W. Vogdes, Ft. Hamilton, New York; Dr. G. Hambach and Prof. W. B. Potter, Washington University, St. Louis; Prof. J. C. Branner, State Geologist, Little Rock, Ark.; and Mr. Arthur Winslow, State Geologist of Missouri. Much other assistance was also received from the gentlemen above named and from Prof. G. C. Broadhead, formerly State Geologist of Missouri, and from Prof. H. S. Williams, Cornell University.

Where there is no statement of the size of the book or paper, it will be understood to be octavo.

No effort has been made to give complete lists of different editions, nor to show what papers in serial publications were issued in pamphlet form as Authors' editions.

The Mineral springs of the State have been included in the list because all the pamphlets describing them have analyses of the mineral waters, and a part of them have accounts of the geology of the country in which the springs are situated.

The title of each work not seen by the compiler is marked by an asterisk.

F. A. SAMPSON.

Sedalia, Mo., August 24, 1890.

BIBLIOGRAPHY.

PART I.

Publications of the State of Missouri.

PUBLICATIONS OF MISSOURI GEOLOGICAL SURVEYS.

(Chronological.)

1

SWALLOW, G. C.—The First and Second Annual Reports of the Geological Survey of Missouri, by G. C. Swallow, State Geologist. By order of the Legislature: James Lusk, Public Printer. Jefferson City, 1855. 240 pp. Plates and maps.

In Shumard's Report on Palæontology, the following species are described: *Pentremiles Sayi*, page 185, Pl. B, Fig. 1, *a, b, c, d*, from near the base of the Encrinital in various counties.

P. Roemeri, page 186, Pl. B, Fig. 2, *a, b, c, d*, from the Chemung at Providence, Boone county.

P. curtus, page 187, Pl. B, Fig. 3, *a, b*, from the Archimedes limestone, St. Louis county.

P. elongatus, page 187, Pl. B, Fig. 4, from the Encrinital limestone, Pike county, Moniteau county.

Poteriocrinus Meekianus, page 188, Pl. A, Fig. 7, *a, b*, probably from the Encrinital, Moniteau county.

P. longidactylus, page 188, Pl. B, Fig. 5, *a, b, c*, St. Louis limestone, St. Louis county.

Actinocrinus concinnus, page 189, Pl. A, Fig. 5, Encrinital limestone, Marion county.

A. Missouriensis, page 190, Pl. A, Fig. 4, *a, b, c*, Encrinital limestone, Marion county.

A. rotundus, Yandell and Shumard, page 191, Pl. A, Fig. 2, *a, b*, Encrinital limestone, Marion county.

A. Christyi, page 191, Pl. A, Fig. 3, Encrinital limestone, Marion and Boone counties.

A. pyriformis, page 192, Pl. A, Fig. 6, *a, b*, Encrinital limestone, Marion county.

A. parvus, page 193, Pl. A, Fig. 9, St. Louis limestone, St. Louis.

A. Verneuilianus, page 193, Pl. A, Fig. 1, *a, b*, Encrinital limestone, Rocheport and Marion county.

A. Konincki, page 194, Pl. A, Fig. 8, *a, b, c*, Encrinital limestone, Boone and Marion counties.

- Glyptocrinus fimbriatus*, page 194, Pl. A, Fig. 10, *a, b*, Cape Girardeau limestone, Cape Girardeau county.
- Tentaculites incurvus*, page 195, Pl. B, Fig. 6, *a, b*, from the same.
- Cythere sublaevis*, page 195, Pl. B, Fig. 15, 1st Magnesian limestone, St. Louis and Ste. Genevieve counties.
- Productus Swallowi*, page 196, Pl. B, Fig. 12, *a, b*, Chemung Group, Chouteau Springs, Cooper county, and in Moniteau county.
- P. Missouriensis*, page 196, Pl. B, Fig. 13, *a, b*, Lithographic limestone, Hannibal, Louisiana and Chouteau Springs.
- Cyphaspis Girardeauensis*, page 197, Pl. B, Fig. 11, *a, b*, Upper Silurian (Cape Girardeau limestone), Cape Girardeau.
- Encrinurus deltoideus*, page 198, Pl. B, Fig. 10, same as last.
- Phillipsia Meramecensis*, page 199, Pl. B, Fig. 9, Archimedes limestone, St. Louis county.
- Dalmanella tridentifera*, page 199, Pl. B, Fig. 8, *a, b, c*, Delthyris Shaly limestone, Perry and Cape Girardeau counties.
- Calymene rugosa*, page 200, Pl. B, Fig. 14, from the same localities.
- Acidaspis Halli*, page 200, Pl. B, Fig. 7, *a, b, c*, Cape Girardeau limestone, Cape Girardeau county.
- Productus æquicostatus*, page 201, Pl. C, Fig. 10, Upper Coal Measures, on Missouri river.
- Chonetes parva*, page 201, Coal Measures, Boone county.
- C. ornata*, page 202, Pl. C, Fig. 1, *a, b, c*, Chemung Group, Cooper and Moniteau counties, Louisiana and Hannibal.
- Spirifer plano-convexa*, page 202, Upper Coal Measures, on the Missouri river.
- S. ? peculiaris*, page 202, Pl. C, Fig. 7, *a, b*, Chemung, Chouteau Springs.
- S. Kentuckyensis*, page 203, Coal Measures, Missouri river, near Weston.
- S. Marionensis*, page 203, Pl. C, Fig. 8, *a, b, c, d*, Chemung, Chouteau Springs, etc.
- Yrtia acutirostris*, page 204, Pl. C, Fig. 3, *a, b, c*, Lithographic Limestone at Hannibal and Louisiana.
- Rhynchonella Missouriensis*, page 204, Pl. C, Fig. 5, *a, b, c*, Chouteau Limestone, Cooper and Boone counties.
- R. Cooperensis*, page 204, Pl. C, Fig. 4, *a, b, c, d*, same as last.
- R. Booneensis*, page 205, Pl. C, Fig. 6, *a, b*, Encrinital limestone, Boone county.
- Orthis Missouriensis*, page 205, Pl. C, Fig. 9, *a, b*, Cape Girardeau limestone, Cape Girardeau.
- Leptaena mesacosta*, page 205, Pl. C, Fig. 2, from same.
- Atrypa circulus*, page 206, Pl. C, Fig. 14, *a, b*, Chouteau Limestone, Cooper and Moniteau counties.
- A. Cooperensis*, page 206, Pl. C, Fig. 15, from same.
- Allorisma Hannibalensis*, page 206, Pl. C, Fig. 19, Lithographic Limestone, Hannibal.
- Pecten Missouriensis*, page 207, Pl. C, Fig. 16, St. Louis Limestone, St. Louis county.
- P. occidentalis*, page 207, Pl. C, Fig. 18, Coal Measures, Clinton county.
- Myalina sub-quadrata*, page 207, Pl. C, Fig. 17, Upper Coal Measures, Missouri river.
- Chemnitzia tennilineata*, page 207, Pl. C, Fig. 12, Chouteau Limestone, Cooper county.
- Murchisonia melaniaformis*, page 208, Pl. C, Fig. 13, 2nd Magnesian Limestone, Franklin county.

Goniatites planorbiformis, page 208, Pl. C, Fig. 11, *a, b*, Coal Measures, Missouri river.

Filicites gracilis, page 209, Pl. A, Fig. 11, Lithographic limestone, Pike and Marion counties.

2

SWALLOW, G. C.—Third Report of Progress of the Geological Survey of Missouri, by G. C. Swallow. [Dec. 1856. For 1855–6.] 3 pp. <Appendix to the Journals 1st Session, Nineteenth General Assembly 1856. Jefferson City, 1857, pp. 245–247.

3

SWALLOW, G. C.—[Fourth] Report of Progress. Geological Survey. By G. C. Swallow. [Dec. 22, 1858. For 1857–8.] <Appendix to Journals, 1st Session, Twentieth General Assembly, 1858. Jefferson City, 1859; pp. 97–106.

4

SWALLOW, G. C.—[Fifth] Report of Progress. Geological Survey. By G. C. Swallow. [Dec. 30, 1860. For 1859–60.] <Appendix to the Journals, 1st Session, Twenty-first General Assembly, 1860. Jefferson City, 1861; pp. 521–533.

5

SWALLOW, G. C. Geological Report of the Country along the Line of the South-western Branch of the Pacific Railroad, State of Missouri. By G. C. Swallow, State Geologist. To which is prefixed a Memoir of the Pacific railroad. St. Louis: Printed by George Knapp & Co., 1859. 93 pp., plates and Geological map of South-west Missouri.

A somewhat fuller report was made by Prof. Swallow, and was published by the Pacific Railroad Company in New York.*

6

HAGAR, A. D.—Annual Report of the State Geologist of the State of Missouri. [Albert D. Hagar. Nov. 30, 1870.] 23 pp. <Appendix, Regular Session, Twenty-sixth General Assembly, 1871; pp. 21–43.

7

BROADHEAD ET AL. Report on the Geological Survey of the State of Missouri; 1855–1871. By G. C. Broadhead, F. B. Meek and B. F. Shumard. Published by authority of the Legislature, under the direction of the Bureau of Geology and Mines. Jefferson City, 1873; pp. 324 and iv.

8

PUMPELLE, R.—Geological Survey of Missouri. Raphael Pumpelly, Director. Preliminary Report on the Iron Ores and Coal Fields from the Field Work of 1872, with 190 Illustrations in the Text and an Atlas. Printed by authority of the Legislature of Missouri, under the direction of the Bureau of Geology and Mines. New York, 1873; pp. xvi. 214, 441. Atlas Accompanying Reports of Missouri Geological Survey, 1874. Jefferson City, 1874.

9

BROADHEAD, G. C.—Report of the Geological Survey of the State of Missouri, including Field work of 1873-1874, with 91 illustrations and an atlas. Garland C. Broadhead, State Geologist. Printed by the authority and under the direction of the Bureau of Geology and Mines. Jefferson City, 1874; pp. 734, L, 4, 56.

10

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11

WILLIAMS, C. P.—Report to the Board of Curators concerning the transfer of the Geological Survey to the School of Mines, and the work executed during the year. By Charles P. Williams, Ph. D., Director Missouri School of Mines and Acting State Geologist. 4 pp. <Missouri State University report for 1876, pp. 213-216.

12

WINSLOW, A.—Geological Survey of Missouri. Arthur Winslow, State geologist. Bulletin No. 1. Contents: Administrative report. By Arthur Winslow, State geologist, page 1. The coal beds of Lafayette county. By Arthur Winslow, State geologist, page 14. The building stones and clays of Iron, St. Francois and Madison counties. By G. E. Ladd, assistant geologist, page 22. The mineral waters of Saline county. By A. E. Woodward, assistant geologist, page 45. A preliminary catalogue of the fossils occurring in Missouri. By G. Hambach, palæontologist, page 60. Published by the Geological Survey. Jefferson City. April, 1890; pp. 85.

13

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GOVERNORS' INAUGURAL ADDRESSES.

(Chronological.)

14

STEWART, R. M.—Inaugural Address of Governor R. M. Stewart. 8 pp. <House Journal, Adjourned Session, 19th General Assembly, 1857. Jefferson City, 1857; pp. 23-30. <Senate Journal, same, pp. 18-25. The mineral resources of the State are noticed.

15

JACKSON, C. F.—Inaugural Address of Gov. C. F. Jackson, Jan. 3, 1861. 8 pp. <Senate Journal, 1st Session, 21st General Assembly, 1860. Jefferson City, 1861; pp. 46-54. <House Journal, same, pp. 45-53.

The Governor refers to the work of the Geological Survey, with favorable mention.

16

PHELPS, J. S.—Inaugural Address of Gov. John S. Phelps. 8 pp. <Senate Journal, Regular Session, 29th General Assembly, 1877. Jefferson City, 1877; pp. —. <House Journal, same, pp. 52-59. He notices the mineral resources and encourages their development.

GOVERNORS' MESSAGES.

(Chronological).

17

BOGGS, L. W.—Message of Governor Lilburn W. Boggs, 16 pp. <Senate Journal, 1st Session, 10th General Assembly, 1838. City of Jefferson, 1839; pp. 13–28.

An appropriation is recommended for establishing a Geological Survey, and for the appointment of a competent and scientific man to direct it. He also gives an account of the survey of the line between Missouri and Iowa.

18

BOGGS, L. W.—Message of Gov. Lilburn W. Boggs, Nov. 17, 1840. 15 pp. <Senate Journal, 1st Session, 11th General Assembly, 1840, pp. 15–29. House Journal, same, pp. 12–26.

Notifies the surveys of the Meramec, Salt, Osage and North Grand rivers; also the geological examination of the Osage river, the latter showing coal, lead and iron.

19

EDWARDS, J. C.—Message of Gov. John C. Edwards, Nov. 16, 1846. <Senate Journal, 1st Session, 14th General Assembly, 1846. Jefferson City, 1847; pp. 25–35. <House Journal, same, pp. 17–28.

The subject of establishing a Geological Survey of the State is recommended to the attention of the Legislature.

20

KING, A. A.—Message of Gov. Austin A. King, Dec. 30, 1850. <Senate Journal, 1st Session, 16th General Assembly, 1850. Jefferson City, 1851; pp. 20–46. <House Journal, same, pp. 30–56.

He favors a geological survey, to be made in a thorough manner and on a liberal scale, but thinks that the General Government should contribute to its accomplishment, and recommends that the memorial of the last Legislature be again pressed upon the attention of Congress. He also strongly recommends the establishment of a School of Mines.

21

PRICE, S.—Message of Gov. Sterling Price, Dec. 25, 1854. 13 pp. <Senate Journal, 1st Session, 18th General Assembly, 1854. Jefferson City, 1855; pp. 14–26. <House Journal, same, pp. 21–32.

This recounts what had been done under the law of the preceding session establishing a Geological Survey, and recommends a further appropriation.

22

PRICE, S.—Message of Gov. Sterling Price, Dec. 29, 1856. <Senate Journal, 1st Session, 19th General Assembly, 1856. Jefferson City, 1857; pp. 14–23. <House Journal, same, same pages.

He states that the results of the work of the survey, as shown by its published reports, must convince every one that the State is most amply compensated for the outlay.

23

STEWART, R. M.—Message of Gov. R. M. Stewart, Dec. 29, 1858. <Senate Journal, 1st Session, 20th General Assembly, 1858. Jefferson City, 1859; pp. 14–37. <House Journal, same, same pages.

The work of the survey is reviewed, and the statement made that the increased sales of lands by means of the publications of the State Geologist had added revenue more than the cost of the survey.

24

STEWART, R. M.—Message of Gov. R. M. Stewart, Jan. 3, 1861. 25 pp. <Senate Journal, 1st Session, 21st General Assembly, 1860. Jefferson City, 1861; pp. 20–44. <House Journal, same, pp. 18–43.

The work of the Geological Survey is reviewed and its continuance recommended.

25

FLETCHER, T. C.—Message of Gov. Thos. C. Fletcher, Jan. 8, 1869. Senate Journal, 1st Session, 25th General Assembly, 1869. Jefferson City, 1869; pp. 13–35. <House Journal, same, pp. 21–44.

He recommends an appropriation sufficient to allow the Board of Immigration to procure from the published and unpublished portions of the Geological Survey of the State, and other reliable sources, the compilation and publication of a concise and practical report on the Geology of the State.

26

MCCLURG, J. W.—Message of Gov. Joseph W. McClurg, Jan. 5, 1870. <Journal, Senate, Adjourned Session, 25th General Assembly, 1870. Jefferson City, 1870, pp. 7–26. <House, same, same pages.

He considers the resources of the State, and the ways of making them known to the people. He declares that there is no question as to the value of Swallow's geological reports.

27

MCCLURG, J. W.—Message of Gov. Joseph W. McClurg to the 26th General Assembly of Missouri. Jefferson City, 1871; pp. 19. Appendix 26th General Assembly, 1871, Regular Session. Senate Journal, same, pp. 14–26.

The Governor expresses the opinion that the Legislature will be gratified with the work of the Geological Survey, and he gives an account of the work of State Geologist Hagar on pp. 14–15, or pp. 22–23 of the Senate Journal.

28

BROWN, B. G.—Message of Governor B. Gratz Brown, made January 26, 1871. 4 pp. <Senate Journal, Regular Session, 26th General Assembly, 1871. Jefferson City, 1871; pp. 124-127. <House Journal, same, pp. 123-127.

Advises the reduction of the number of the Board of Managers of the Mining, Metallurgical and Geological Bureau, so as to make it more efficient.

29

BROWN, B. G.—Message of Governor B. Gratz Brown to the Adjourned Session of the 26th General Assembly of the State of Missouri, December 6, 1871. Jefferson City, 1871. <Appendix Adjourned Session 26th General Assembly, Jefferson City, 1871. <Senate Journal, same, pp. 6-31. <House Journal, same, pp. —.

This notices the mineral development of the State and the work of the Geological Survey.

30

CRITTENDEN, T. T.—Message of Governor Thos. T. Crittenden, Jan. 7, 1885. <Senate Journal, Regular Session, 33d General Assembly, 1885. Jefferson City, 1885, pp. 12-71. <House Journal, same, pp. 17-76.

Announces that he had appointed James F. Brooks to take charge of the topographical survey of the sunk and overflowed lands of Southeast Missouri, which had been provided for by a previous Legislature, and that the engineer had expended the appropriation, but made no report.

31

MOREHOUSE, A. P.—Message of Governor Albert P. Morehouse, Jan. 9, 1889. <Appendix to Senate and House Journals. Regular Session, 35th General Assembly, 1889, pp. 1-26.

He approves of the law establishing a State Mine Inspector, and urges a larger appropriation, so that the Mine Inspector can be kept in the field and keep pace with the rapidly increasing mining interests of the State.

REPORTS OF LEGISLATIVE COMMITTEES.

(Chronological.)

MISCELLANEOUS COMMITTEES.

32

IRON MOUNTAIN.—Report by Mr. Monroe of the Select Committee to consider the subject of the Iron mountain. 2 pp. <Senate Journal, 1st Session, 10th General Assembly, 1838. City of Jefferson, 1839; pp. 208-209.

The committee reports in favor of the State helping to build a railroad from Iron mountain to Iron Mountain City, on account of the benefit to the people from the development of the iron mines belonging to the Missouri Iron Mountain company.

33

AMERICAN IRON MOUNTAIN COMPANY.—Report of the Select Committee respecting the incorporation of the American Iron Mountain company. <House Journal, Appendix, 1st Session, 12th General Assembly, 1842. Jefferson City, 1843; pp. 640-643.

34

PUBLIC SALINES.—Report of Committee on Public Salines, 1 page. <House Journal, Appendix, 1st Session, 13th General Assembly, 1844. City of Jefferson, 1845; p. 229.

The committee reports that the total quantity of land selected by the State for saline purposes was 47,259.65, of which there had been sold 32,075.88 acres.

35

INTERNAL IMPROVEMENT.—Report of the Committee on Internal Improvements, in favor of a Geological Survey of the State. (Signed by) Dewitt C. Ballou, of Benton, Chairman. 8 pp. <House Journal, Appendix, 1st Session, 14th General Assembly, 1846. Jefferson City, 1847; pp. 250-257.

This report is strongly in favor of establishing a Survey, and the committee presented a bill for that purpose.

36

MANUFACTURES AND CORPORATIONS.—Report of the Select Committee on Manufactures and Corporations. 8 pp. <Senate Journal, Appendix, 1st Session, 15th General Assembly, 1848. Jefferson City, 1848; pp. 188–195.

The committee directs attention to the vast mineral resources of the State offering inducements to manufacturers of every article of iron, steel, copper and lead; and also to the “china clay, feldspar, sillex, mica, magnesia and cobalt.”

37

INTERNAL IMPROVEMENT.—Report of Committee on Internal Improvements in regard to Swamp lands; p. 232. Report of Committee on Internal Improvements on the bill granting the right of way for the Mississippi & Pacific Railroad; p. 246. <Senate Journal, Appendix, 1st Session, 15th General Assembly, 1848.

The first refers to the memorial of the Bloomfield convention in 1847, and the second recites the advantages the road would be to the utilization of “the vast mines of iron ore and inexhaustible deposits of coal that abound in Missouri.”

38

PRINTING GEOLOGICAL REPORT.—Report of Committee on Printing Prof. Swallow’s Report on Geological Survey; 1 page. <House Journal, Appendix, 1st Session, 18th General Assembly, 1854. Jefferson City, 1855; p. 393.

39

GEOLOGICAL SURVEY.—Report of the Joint Committee on the Geological Survey. January 15, 1859; 1 page. <Appendix to the Journals, 1st Session, 20th General Assembly. Jefferson City, 1859; p. 408.

The Committee reports unanimously in favor of continuing the survey.

40

GEOLOGICAL SURVEY.—Account of expenditures of Bureau of Mines, etc. <Appendix to Journals, Regular Session, 26th General Assembly, 1871; p. 128 of documents accompanying Governor’s message.

This account is from Oct. 1, 1870, to Dec. 1, 1870, under Hagar.

REPORTS OF THE COMMITTEES ON MINES, ETC.

41

1873.—Report on the Mines, Manufactures and other Interests of the State of Missouri, by the House Committee, 27th General Assembly, Regular Session, Jefferson City, 1873. March 10, 1873, 67 pp. German edition, 102 pp. <Journal of the House of Representatives, Regular Session, 28th General Assembly; pp. 1397–1461.

42

1874.—Report on the Mines, Manufactures and other Interests of the State of Missouri, by the House Committee on Manufactures; 27th General Assembly, Adjourned Session. Jefferson City, 1874. March 26, 1874. 115 pp. German edition, 120 pp.

43

1875.—Report of Committee on Mines and Mining. Feb. 16, 1875. 5 pp. <Journal House, Regular Session, 28th General Assembly, 1875. Jefferson City, 1875; pp. 621-625.

This is a report on the School of Mines at Rolla.

44

1879.—Report of Committee on Mining and Manufacturing. April 2, 1879. 3 pp. <Appendix Senate and House Journals of 1879. Part 22. Jefferson City, 1879.

This is also a report on the School of Mines.

45

1881.—Report of Committee on Mining and Manufactures to the 31st General Assembly of Missouri, March 18, 1881. 21 pp. <Appendix Senate and House Journals, Regular Session, 31st General Assembly, 1881. Jefferson City, 1881.

MEMORIALS TO THE LEGISLATURE.

(*Chronological*)

46

INTERNAL IMPROVEMENT CONVENTION.—A Memorial to the General Assembly from the Committee appointed for that purpose, by the Internal Improvement Convention, held at Springfield, Mo., in Oct., 1846. (Signed by) F. P. Wright, James M. Major and James Winston. 5 pp. <Appendix House Journal, 1st session, 14th General Assembly, 1846. Jefferson City, 1847; pp. 245-249.

This urges an appropriation for improving the Osage river, and recites the results of a scientific survey of the river by Mr. Morell, engineer, in 1840, and the benefits to be obtained from the mineral and other resources of the part of the State traversed by the river.

47

HISTORICAL AND PHILOSOPHICAL SOCIETY.—Memorial on the subject of a Geological Survey of the State, to the General Assembly of Missouri. (Signed by) Falkland H. Martin, Sol. D. Caruthers, S. T. Glover, W. G. Minor and DeWitt C. Ballou, a Committee of the Historical and Philosophical Society of Missouri. 13 pp. <Appendix House Journal, 1st Session, 15th General Assembly, 1848. Jefferson City, 1849; pp. 175-187.

The Society urges the Legislature to order a geological survey of the State, and among the special reasons for doing so is the reclamation of the country affected by the New Madrid earthquake of 1811, concerning which they say: "The effects of which are still to be seen in yawning chasms, where the solid earth was rent in twain, and in the vast lakes and marshes which cover the sunken surface of the land in many places through a region of country extending several hundred miles."

48

CITIZENS OF CAPE GIRARDEAU.—Memorial from the citizens of Cape Girardeau in reference to a railroad. (Signed by) Albert Jackson and nine others. 4 pp. <Senate Journal, Appendix 1st Session, 15th General Assembly, 1848. Jefferson City, 1848; pp. 203-206. House Journal, Appendix, same, pp. 208-211.

The Legislature was then considering a railroad route from Lexington to some point on the Mississippi. This report shows that Cape Girardeau was the only eligible terminus; that New Madrid was not a proper point because the banks of the river at that place were constantly caving in; that Ohio City, opposite the mouth of the Ohio river, could not be reached, it being thirty miles from the highlands, this distance being traversed by lakes and swamps, and these, with annual overflow from the rivers, precluding the building of a road on this route; Commerce was the first point from the mouth of the Mississippi river having a rock-bound shore. To reach it, however, the great swamp would have to be crossed at a point two miles from Cape Girardeau. The swamp here is at its narrowest, and is about three miles wide, presenting indications that this swamp was formerly the bed of the Mississippi river. When the river rises to a considerable height a part of its water flows through the swamp, covering it from bank to bank from three to fifteen feet. The advantages of Cape Girardeau by reason of its proximity to the mineral region of Washington, St. Francois and Madison counties are also noticed.

49

PACIFIC RAILROAD.—Memorial of the President and Directors of the Pacific railroad to the General Assembly of the State of Missouri. <Senate Journal, Appendix, Regular Session, 17th General Assembly, 1852. Jefferson City, 1852; pp. 3-24.

In addition to the memorial there is a report by the Chief Engineer, Thos. S. O'Sullivan, with estimates and grades of the different proposed routes.

50

STATE AGRICULTURAL SOCIETY.—Memorial of the State Agricultural Society to the General Assembly. 3 pp. <Appendix to the Journals 1st Session 18th General Assembly, 1854. Jefferson City, 1855; pp. 310-312.

The society asks that the State Geologist be directed to give special attention to the agricultural interests of the State, examine soils and fertilizers, etc.

51

SWALLOW, G. C.—Letter from Prof. Swallow to the Secretary of State, Nov. 30, 1855. 2 pp. <House Journal, Appendix, Adjourned Session, 18th General Assembly, 1855. Jefferson City, 1856; pp. 301-2.

This accompanies the transmission of a part of the First and Second Annual reports.

52

REED, SILAS.—Memorial to Congress on the subject of the Development of the Mineral Resources of Missouri. (Signed by) Silas Reed, Stanton Copper Mines, Franklin county, Missouri, Feb. 13th, 1857; pp. 8. <Appendix Senate Journal, 1st Session, 19th General Assembly, 1856. Jefferson City, 1857; pp. 345-352.

This states that the writer, on his own account, and in behalf of his associates, and the Stanton Copper Mining company, entered land in 1845 which he believed contained a valuable copper vein, and in 1848 he had explorations made. He found a very rich vein and erected copper smelting works; but on account of want of skill the first and second years were failures. The third year was more satisfactory, and in 1851 they erected a fourth furnace. They extended their shafts and drifts, and from 1853 to 1855 employed steam power. The vein under the engine house at its deepest level yielded ore of 60 per cent pure copper. In the north hill, where the main body was found, the vein changed to mundic, which was too poor in copper to pay for working, and the company suspended mining operations in 1855. The geological formation of the different mines in Missouri is described, and Congress is urged to donate one or more townships to Missouri for the purpose of sinking deep shafts, and thoroughly testing the extent of the minerals, the profits to be devoted by the State to the founding of a School of Miners.

53

McKENZIE, JAMES.—Petition to the Honorable, the Senate, etc., of James McKenzie, of St. Louis. 2 pp. <Senate Journal, Appendix, Adjourned Session, 22d General Assembly, 1863. Jefferson City, 1863; pp. 31-32.

This called the attention of the Legislature to the need of foreign capital to develop the mineral resources of the State.

Also report of Senator Muench, Chairman of the Select Committee to which the memorial was referred. <Senate Journal, same, pp. 69-71.

54

MEMORIAL.—A memorial to the President and Congress of the United States and to the Secretary of War, asking for a Fort or Garrison, to be established near the southwestern corner of the State. 3 pp. Appendix Senate Journal, Regular Session, 23d General Assembly. Jefferson City, 1865; pp. 600–602.

The reasons for the establishment of the garrison by the Government were the disturbed condition of the country, the existence of "the finest and largest salt springs in America," and the mineral resources of Southwest Missouri. The different mines and furnaces were noticed

55

KANSAS LEGISLATURE.—Resolutions adopted by the Kansas Legislature relative to Geological Survey. 1 page. <Senate Journal, Appendix, Adjourned Session, 23rd General Assembly, 1865–6. Jefferson City, 1866; page 570.

This was a request for a permit for the State Geologist of Kansas to use in his report to that State the information gained by him while Geologist of Missouri.

56

ST. LOUIS ACADEMY OF SCIENCE.—Memorial of the Academy of Science of St. Louis, to the Legislature, Jan. 21, 1867. (Signed by) Nathaniel Holmes, Benjamin Shumard, Enno Sander, committee. 1 p. <Appendix House Journal, 24th General Assembly, page 125. Jefferson City, 1867.

The memorial asks that the work of the Geological Survey be completed and the results published.

57

ST. LOUIS ACADEMY OF SCIENCE.—Resolutions passed by the Academy of Science of St. Louis. Geological Survey. 1 page. <Appendix House Journal, 24th General Assembly. Jefferson City, 1867; page 571.

This was a protest against the transfer of the matter appertaining to the State Survey to the hands of any one except the late State Geologist.

REPORTS OF STATE BOARDS.

(Chronological)

REPORTS OF BOARDS OF INTERNAL IMPROVEMENTS & OF PUBLIC WORKS.

58

INTERNAL IMPROVEMENTS.—Journal of the Proceedings of the Board of Internal Improvements. Report of the Board of Internal Improvements to the General Assembly of Missouri, pp. 485–525.

Report of Chief Engineer Morell, pp. 484–525.

Report of a Geological Reconnoissance of that part of the State of Missouri adjacent to the Osage River, made to William H. Morell, Chief Engineer of the State, by order of the Board of Internal Improvement, by Henry King, M. D., Geologist, President of the Western Academy of Natural Sciences, etc., etc.; pp. 506–525. <Senate Journal, Appendix, 1st Session, 11th General Assembly, 1840; pp. 458–525.

The Journal gives the proceedings of the meetings from May 6, 1839, to Dec. 29, 1840, showing the appointment of William H. Morell as Chief Engineer of the State, of Commissioners for the Surveys of the North Grand, Salt, Osage and Meramec rivers and the railroad route from St. Louis to the Iron Mountain, and the appointment of Dr. H. King as Geologist of the Osage river survey.

59

LEVEE COMMISSIONERS.—Report of the State Commissioners of their survey of the levee and canal in New Madrid county, to the General Assembly of Missouri, Sept. 23, 1848. (Signed by) Godfrey Lesieur, Thos. C. Powell, James Eastwood, John Hamlin and S. G. Kitchen. 7 pp. <Senate Journal, Appendix, 1st Session, 15th General Assembly, 1848, Jefferson City, 1848; pp. 197–203; <House Journal, Appendix, same, pp. 202–207.

The condition of the streams, swamps and morasses in Southeast Missouri at that time is described. The Commissioners found an "ocean of water" from the junction of Castor with Little river, about eight miles wide and extending towards Bloomfield, twenty or thirty miles, and averaging two and one-half feet deep, and this was so matted with "wild corn" that after trying for three days to work their way through in canoes they decided that it was impossible. Their survey was in the part of the State where the earthquake of 1811 was so disastrous.

60

RAILROAD.—Report of the Cairo & Fulton Railroad Co. Communication to the Governor, Jan. 23, 1855; pp. 10. <Appendix to the Journals, 1st Session, 18th General Assembly, 1854. Jefferson City, 1855; pp. 289-298.

The report of James S. Williams, Chief Engineer, has a detailed and interesting account of the topography of the Missouri section of the road.

61

BOARD OF PUBLIC WORKS—Pacific Railroad.—Report of the Board of Public Works made to the Governor of the State of Missouri, Dec. 1855. <Senate Journal, Appendix, Adjourned Session, 18th General Assembly, 1855. Jefferson City, 1855; pp. 159-221. <House Journal, Appendix, same, same pages.

The report of Thomas S. O'Sullivan, engineer and superintendent, on the surveys of the Pacific railroads, is on pages 165-170.

62

IRON MOUNTAIN RAILROAD.—Statement of the condition of the affairs of the St. Louis & Iron Mountain Railroad Company, Feb. 1, 1856. <Appendix, House Journal, 1st Session, 19th General Assembly, 1856. Jefferson City, 1857; pp. 415-422.

This has reports by Madison Miller, president, and J. B. Moulton, chief engineer.

REPORTS OF THE BOARD OF IMMIGRATION.

(Chronological.)

63

WATERHOUSE, S.—The Resources of Missouri, by S. Waterhouse, St. Louis. Edition, 20,000 copies. St. Louis, Mo., 1867. 64 pp.

This was also issued as part of a State publication entitled "Reports Board of Immigration and Commissioner of Statistics, Missouri, 1867," and was prepared at the request of the State Board of Immigration.

64

WATERHOUSE, S.—The Resources of Missouri and the Natural Adaptation of St. Louis to Iron Manufactures. By Sylvester Waterhouse, St. Louis. Second enlarged edition. St. Louis, 1869. 64 and 31 pp.

65

BOARD OF IMMIGRATION.—Missouri, its Progress and Resources, being a part of the Third Biennial report of the Board of Immigration. 11 pp. <Third Biennial Report of the Board of Immigration, Jefferson City, 1871. <Appendix 26th General Assembly, Regular Session, 1871.

66

O'NEILL, J. J.—Resources of the State of Missouri, by Hon. John J. O'Neill, Chairman of the House Committee on Immigration. 29th General Assembly. Published for gratuitous distribution by order of the House. Jefferson City; Regan & Carter, State Printers and Binders, 1877; pp. xxv, 149, v.

67

BOARD OF IMMIGRATION.—The Agricultural, Manufacturing, Commercial and Geographical Center of the Mississippi Valley, Missouri, the Imperial State, its Wealth and Resources. 1880. 72 pp.

<First Biennial report of the State Board of Immigration, January, 1881. Jefferson City, 1881; pp. 21-92.

This part of the report was also issued as a separate pamphlet of 48 pages.

REPORT OF COMMISSIONER OF STATISTICS.

68

SWALLOW, G. C.—Physical Geography of Missouri. From unpublished notes of the Geological Survey. By G. C. Swallow. 29 pp. First Annual Report of the Commissioner of Statistics to the General Assembly of the State of Missouri, for the year 1866; pp. 97-125.

This report was also published as a part of Appendix, House Journal, 24th General Assembly, 1867. Jefferson City, 1867; pp. 719-747. It was also published as part of a volume entitled "Report Board of Immigration and Commissioner of Statistics, Missouri, 1867." See also Agricultural Reports of Missouri.

REPORTS OF THE BUREAU OF LABOR STATISTICS.

(Chronological.)

69

HILKENE, W. H.—Mining. <First Annual Report of the Labor Bureau for 1879. [W. H. Hilken, Commissioner.] Jefferson City, 1880; pp. 89-94.

70

HILKENE, W. H.—Wages and Modes of Payment.—Mining. Coal, Lead, and Iron. <Second Annual Report for 1880. Jefferson City, 1881.

In the first article the modes of payment by different coal, lead and iron companies in the State are given on pages 24-38. The second article has much of interest in regard to the methods of operating the various mines of the State; pp. 89-127.

71

SPAUNHORST, H. J.—Mine Inspectors' Reports. <Fourth Annual Report Labor Bureau, for 1882. Henry J. Spaunhorst, Commissioner. Jefferson City, 1883; pp. 147-152. <German edition, pp. 151-157.

72

NEWMAN, H. A.—Mine Inspector's Reports for the year 1882. Tabulated Statement Mine Inspector's Reports. <Fifth Annual Report for 1883. Jefferson City, 1884. H. A. Newman, Commissioner; pp. 81-127.

The second title includes reports for 1883, the first having those which were omitted from the report of the previous year.

73

NEWMAN, H. A.—Mine Inspector's Report for the year 1884. <Sixth Annual Report for 1884. H. A. Newman, Commissioner; pp. 269-299.

74

KOCHTITZKY, OSCAR.—Seventh Annual Report of the Bureau of Labor Statistics of the State of Missouri, for the year ending Dec. 31, 1885. Jefferson City, 1886. Oscar Kochtitzky, Commissioner.

This has the following: Coal Miners' Strike at Bevier, pp. 14-18. Coal Mine Inspectors' Reports [for 1885], pp. 117-155. Lead Mines, Lead and Zinc Mining, pp. 157-160. Missouri Labor Laws. Mining Laws. Weighing of Coal. Inspection of Mines, pp. 209-228.

75

KOCHTITZKY, OSCAR.—Eighth Annual Report of the Bureau of Labor Statistics, 1886.

This contains Mines and Mining (Mine Inspectors' Reports for 1886), pp. 29-87.

76

KOCHTITZKY, OSCAR.—State Mine Inspector. <Ninth Annual Report for 1887. Jefferson City, Mo., 1888; pp. 16-22.

This has the act of the legislature of March 30, 1887, for the appointment of a State Mine Inspector instead of County Mine Inspectors, and of the action of the Bureau in the matter.

77

WOLFE, M. L.—First Annual Report of the State Mine Inspector. M. L. Wolfe, State Mine Inspector. 82 pp. <Ninth Annual Report for 1887, pp. 177-258.

78

KOCHTITZKY, OSCAR.—Special report to the Governor of an investigation by the Commissioner of Labor Statistics and Inspection (including State Mine Inspector's Report and Papers by Mining Experts), of the coal mine explosion at Rich Hill, Mo., March 29, 1888. St. Louis, Mo., 1888; p. 63, v, folded diagram. Also Tenth Annual Report Labor Bureau.

79

POTTER, W. B.—Report of William B. Potter, Mining Engineer. 20 pp. and folded plan. <Special report of Commissioner of Labor Statistics and Inspection on Coal Mine Explosion at Rich Hill, Mo. March 29, 1888. St. Louis, Mo., 1888; pp. 38-57. <Tenth Annual Report of the Labor Bureau. Jefferson City, 1889.

80

WOLFE, M. L.—Report of the State Mine Inspector for 1888. <Tenth Annual Report Labor Bureau, Jefferson City, 1889; pp. 59-125.

81

WOLFE, M. L.—Report of Hon. M. L. Wolfe, State Mine Inspector. 30 pp. Special report, etc., Coal Mine Explosion at Rich Hill, Mo., March 29, 1888. St. Louis, Mo., 1888; pp. 8-37. <Tenth Annual Report of the Labor Bureau. Jefferson City, 1889.

82

MERIWETHER, LEE.—Eleventh Annual Report of the Bureau of Labor Statistics, 1889. Lee Meriwether, Commissioner; pp. 517, v.

This report is taken up nearly altogether with mining matters.

83

WOODSON, O. C.—Report of the State Mine Inspector for the year 1889. <Eleventh Report, Labor Bureau, pp. 447–517.

ANNUAL REPORTS OF THE STATE UNIVERSITY.

(*Alphabetical*)

84

BROADHEAD, G. C.—The Relation of the Soils of Missouri to Geology. (Lecture delivered in the University Chapel, March 29, 1884.) By G. C. Broadhead of Pleasant Hill, Mo., former State Geologist. 8. pp. <Report of 1883–4, pp. 72–79.

85

COMMITTEE REPORT.—Report of the Committee on the location of the School of Mines. <Report of 1871, pp. 16–22.

This report describes the minerals found in Phelps county, the committee reporting in favor of locating the school in that county.

86

READ, DANIEL.—Address delivered upon the occasion of the formal opening of the School of Mines at Rolla, on the 23d of November, 1871. By Daniel Read, LL. D., President of the University. 12 pp. <Report of 1872, pp. 121–132.

87

ROLLINS, J. S.—Report of the Board of Curators of the State University. <Report of 1876, pp. 9–10.

Maj. J. S. Rollins, as President of the Board of Curators, recommends that the Board be created a Board of Geological and Agricultural Survey, and of Agricultural and Economic Statistics.

88

SCHWEITZER, P.—Contributions from the Laboratory of the State University. Columbia Chalybeate Spring. The Water Supply of the

Town of Columbia, Boone County, etc., etc., by P. Schweitzer, Ph. D., Professor of Analytical and Applied Chemistry. 10 pp. <Report of 1874, pp. 160-169.

89

SCHWEITZER, P.—Contributions from the Laboratory of the State University. <Report of 1875, pp. 155-193.

This contains reports "On the true Composition of Coal, and on the methods of arriving at it, with deductions and remarks on Coal in general, illustrated on a sample of coal from the Lower Coal series of Missouri," and on "The water supply of Columbia, Boone county, Missouri; being an exposition of the origin of the springs and subterranean Water-courses of the town and neighborhood, with some analyses of elstern water."

90

SCHWEITZER, P.—Contributions, etc. The Various Methods of Separating and determining Baryum, Strontium and Calcium. Part 1. Determination of Baryum. 36 pp. <Report of 1876, pp. 161-196.

91

SWALLOW, G. C.—Report of Prof. Swallow, on the Agricultural and Mechanical College. By G. C. Swallow, Professor of Agriculture. 26 pp. <Report of 1871, pp. 81-105.

The report contains descriptions and analyses of the soils of Missouri on pages 94-105.

92

WILLIAMS, C. P.—Contributions to a Knowledge of the Iron Ores of Missouri. By Prof. Chas. P. Williams, Director of the School of Mines. 15 pp. <Report of 1872, pp. 133-147.

The report contains analyses of many Missouri iron ores.

93

WILLIAMS, C. P.—The Missouri Zinc Ores and their Products, with some Miscellaneous Analyses. 11 pp. <Report of 1874, pp. 149-159.

94

WILLIAMS, C. P.—Contributions from the Laboratory of the School of Mines. <Report of 1875, pp. 195-208.

The subjects treated are: "Commercial Leads of Missouri," "Zinc Oxide, or White, Manufactured in Missouri," and "Chemical Study of the Ozark Blast Furnace."

95

WILLIAMS, C. P.—Contributions from the Laboratory of the Missouri School of Mines and Metallurgy. (University of Missouri.) No. IV. 16 pp. <Report of 1876, pp. 197–212.

This contains the following titles: Composition of Missouri Leads; Copper Ores of Shannon County; Some Mineral Species associated with Hematite Ore at Buckland's bank, Phelps county; Metallurgical Products from Mine La Motte; Smithsonite from Dade county; Sweet Springs water, Saline county; Oxide of Zinc prepared from Missouri ores.

96

WILLIAMS, C. P.—Report to the Board of Curators concerning the Transfer of the Geological Survey to the School of Mines, and the work executed during the year. 4 pp. <Report of 1876, pp. 213–216.

REPORTS OF THE BOARD OF AGRICULTURE.¹

(Alphabetical.)

97

ANONYMOUS.—Report of a reconnoissance along the line of the Western Branch of the North Missouri railroad, from Moberly to Leavenworth. 8 pp. <First Report, 1865, pp. 174–181. <Appendix Senate Journal, Adjourned Session, 23d General Assembly. Jefferson City, 1865–6; pp. 174–181.

98

BLOW, H. T.—The Iron State. Mines and Mining in Missouri. Address of Hon. H. T. Blow before the School of Mines, Feb. 4, 1873. 12 pp. <Eighth Report, 1872, pp. 478–489.

99

BROADHEAD, G. C.—Mineral Springs of Missouri. By Garland C. Broadhead. (Read before the St. Louis Academy of Science, October 18, 1864.) 5 pp. <Second Report, 1866, pp. 99–103.

100

BROADHEAD, G. C.—Caves in Missouri. (From Missouri Republican. Nov. 7, 1863.) 4 pp. <Third Report, 1867, pp. 201–204.

¹The first report of the series was that for 1865. They have been published in German, as well as in English, and a part of them in some other languages.

101

BROADHEAD, G. C.—Paints and Clays [of Missouri.] 2 pp. <Third Report, 1867, pp. 200–201.

102

BROADHEAD, G. C.—The Relation of the Soils of Missouri to Geology. Lecture delivered in the University Chapel, March 29, 1884. 10 pp. <Seventeenth Report, 1885, pp. 159–168.

103

BROADHEAD, G. C.—Sketch of Geology of Missouri. 10 pp. <Eighteenth Report, 1885, pp. 250–259.

104

ELLIOTT, R. S.—The Minerals of Missouri. Address before State Board of Agriculture and Members of the Legislature of Missouri, in the Hall of the House of Representatives, at Jefferson City, Jan. 30, 1868, by R. S. Elliott, of St. Louis. 16 pp. <Third Report, 1867, pp. 228–243.

105

GWYNN, J. K.—Southwest Missouri, Its Possibilities and Resources. By J. K. Gwynn. <Twenty-second Report, 1889–90, pp. 260–267.

About half a page is here devoted to a brief reference to the lead, zinc, coal, iron and other deposits of this section of the State.

106

MAGWIRE, J.—The advantages and adaptability of St. Louis as a manufacturing city. By John Magwire. 29 pp. <Second Report, 1866, pp. 122–140.

The mineral advantages are especially considered.

107

MILLIGAN, E.—Missouri Mines. By Ed. Milligan. 2 pp. <First Report, 1865, pp. 161–162 of Appendix. <Appendix Senate Journal, Adjourned Session, 23d General Assembly. Jefferson City, 1865–6; pp. 161–162.

108

MILLIGAN, E.—Missouri as a Manufacturing State. What Nature has Done for Her. 8 pp. <Second Report, 1856, pp. 115–122.

109

MOREHOUSE, A. P.—Northwest Missouri, Its Resources and Possibilities. By Ex-Gov. Albert P. Morehouse. <Twenty-second Report, 1889-90, pp. 242-251.

Refers to existence of coal in the northwestern counties.

110

MORSE, L. D.—Report of the Corresponding Secretary. By L. D. Morse. <First Report, 1865, pp. 7-132. <Appendix Senate Journal, Adjourned session, 23d General Assembly, 1865-6, pp. 151-276.

This has copy of the resolutions of the State Agricultural Society in 1864 in favor of a Geological Survey. p. 9.

Also, "The Importance of a Scientific Survey," pp. 129-132, in which is given the action of the State Board of Agriculture on the same subject at its meeting December 27, 1865.

111

PHILLIPS, J. V.—The Wine District of Missouri. By J. Vancleve Phillips, Geologist and Mining Engineer. 10 pp. <Third Report, 1867, pp. 72-81.

112

RIPPEY, M.—Northeast Missouri. By Maud Rippey. <Twenty-second Report, 1889-90, pp. 237-242.

This contains a paragraph referring to the existence of coal in the northeastern counties.

113

SANBORN, J. W.—Resources of Missouri. <Seventeenth Report, 1883. J. W. Sanborn, Secretary, pp. 150-158.

The mineral and other resources of the State are detailed.

114

SPENCER, J. W.—Primitive Origin of Soils. By J. W. Spencer, Ph. D., F. G. S., Professor of Geology, University of Missouri. 11 pp. <Eighteenth Report, pp. 380-390.

115

STATE BOARD.—Report of the Committee and action of the Board of Agriculture in regard to establishing the offices of State Geologist and State Entomologist, December 5, 1867. 2 pp. <Third Report, 1867, pp. 17-18.

116

SWALLOW, G. C.—Physical Geography of Missouri. From the unpublished notes of the Geological Survey. By G. C. Swallow. 42 pp. <Second Report, 1866, pp. 58–96.

117

SWALLOW, G. C.—Practical and Scientific Agriculture. 9 pp. <Second Report, 1866, pp. 164–172.

The connection of Geology with the soils of Missouri is considered.

118

SWALLOW, G. C.—Agricultural Education. Address of Professor G. C. Swallow, delivered before the State Board of Agriculture, in the House of Representatives, at Jefferson City, January 29, 1868. <Third Report, 1867, pp. 204–215.

This copies the resolutions of the State Agricultural Association in 1865 in favor of a Geological Survey.

119

SWALLOW, G. C.—Grape Culture in Missouri. 13 pp. <Third Report, 1867, pp. 215–227.

Analyses of soils are given and the effect of geological formations on soils considered.

120

SWALLOW, G. C.—Nomenclature and Classifications of Soils. 18 pp. <Thirteenth Report, 1878, pp. 152–169.

121

SWALLOW, G. C.—Missouri Soils. 5 pp. <Fifteenth Report, 1880–1, pp. 277–281.

122

SWALLOW, G. C.—The Tobacco Lands of Missouri. 25 pp. <Fifteenth Report, 1880–1, pp. 282–308.

123

SWALLOW, G. C.—Ozark Highlands. Report on the Agricultural College Lands Lately Sold. By G. C. Swallow, State Geologist, June 1, 1881. 6 pp. <Fifteenth Report, 1880–1, pp. 309–314.

124

THOMPSON, R. O.—The Influence of Mining Industries on Agricultural Pursuits. Our Mineral Deposits and Agricultural and Horticultural Capacities. By R. O. Thompson. 14 pp. <Seventh Report, 1871, pp. 50–63 of the Report of the Corresponding Secretary.

125

TICE, J. H.—Southeast Missouri. Its great and varied mineral and agricultural resources. By John H. Tice, Corresponding Secretary. <Third Report, 1867, pp. 262–269.

126

TICE, J. H.—Board of Agriculture. By John H. Tice. <Second Report, 1866, pp. 160–164.

Mr. Tice, as Secretary of the Board, here advocates that it should have under it a chemist, a geologist, a metallurgist, etc.

127

WILBER, C. D.—Mineral Wealth of Missouri. Two lectures delivered in the Hall of Representatives, Jefferson City, Mo., Feb. 17th and 18th, 1870, in accordance with House Resolutions. I. Mines and Mining Education. II. Coal and Iron. By Professor C. D. Wilber, Inspector of Mining Lands. With an Appendix. 50 pp. <Fifth Report, 1869, pp. 219–269.

As issued in 1870 the pamphlet contains 67 pages.

COUNTY REPORTS MADE TO BOARD OF AGRICULTURE.

(Alphabetical.)

Among the county reports made to the State Board of Agriculture, and published in the Annual Reports, the following are worthy of note as containing interesting matter relating to the geology, mineralogy or mines.

128

ALEXANDER, J. H.—St. Charles County. By Joseph H. Alexander, St. Charles. 18 pp. <First Report, 1865, pp. 87–114.

129

BADGER, A.—Vernon County. By Albert Badger. <Second Report, 1866, pp. 309–313.

130

BODENHAMER, B. J.—Webster County. By B. J. Bodenhamer. <Second Report, 1866, pp. 314–317.

131

BROADHEAD, G. C.—Cass County. By G. C. Broadhead. 4 pp. <Second Report, 1866, pp. 226–229.

This includes both the botany and the geology of the county.

132

CLARK, G. B.—Washington County. By Geo. B. Clark, Secretary Washington county J. S. A. & M. A. <Fifth Report, 1869, pp. 111–115.

133

CLARK, G. B.—Washington County. <Sixth Report, 1870, pp. 125–129.

134

COLLIER, S. C.—Madison County. By S. C. Collier. <Third Report, 1867, pp. 309–312.

135

JEWETT, W. S.—Jefferson County. By W. S. Jewett. <Second Report, 1866, pp. 271–275.

136

McMANUS, J. P.—Bollinger County. By John P. McManus. <Seventh Report, 1871, pp. 226–229.

137

MOREROD, J. R.—Vernon County. By J. R. Morerod. <Seventh Report, 1871, 314–327.

138

SEARLE, E. P.—Jasper County. By E. P. Searle. <Seventh Report, 1871, pp. 271–282.

“Joplyn” is reported as a mining town only a few months old, and as having two furnaces and from thirty to fifty paying shafts.

139

WHITNEY, D. W.—Franklin County. By D. W. Whitney. <Second Report, 1866, pp. 249–253.

PART II.

Publications of the United States Government.

UNITED STATES GEOLOGICAL SURVEYS.

(*Alphabetical.*)

140

DAY, D. T. Mineral Resources of the United States. Calendar Year 1885. Division of Mining Statistics and Technology. David T. Day, Geologist in charge. Dept. of the Interior. U. S. Geological Survey. J. W. Powell, Director, Washington, 1886.

This volume contains the following relating to Missouri:

Missouri coal, pp. 230, 280-282; Coke, pp. 401-402; Copper, p. 112; Iron, p. 14; Iron ores, pp. 97-98; Lead, pp. 147-148; Limestones, p. 541; Limonite, pp. 97-98; Manufactured fertilizers, p. 625; Mineral waters, p. 717; Ocher, p. 709; Zinc, p. 135; Other, pp. 18, 282, 98, 533.

141

— Mineral Resources of the United States. Calendar Year 1886. David T. Day, Chief of Division of Mining Statistics and Technology. Dept. of the Interior. U. S. Geological Survey. J. W. Powell, Director. Washington, 1887.

This volume contains the following:

Missouri barites, p. 523; Coal, pp. 11, 35-36; Copper, p. 210; Feldspar, p. 533; Fertilizers, p. 469; Iron, p. 182; Lead, p. 259; Manganese, pp. 346-348; Mineral waters, p. 538; Ocher, p. 538; Missouri Zinc company, p. 273.

142

— Mineral Resources of the United States. Calendar Year 1887. David T. Day, Chief of Division of Mining Statistics and Technology. Dept. of the Interior. U. S. Geological Survey. J. W. Powell, Director. Washington, 1888.

This volume contains the following:

Missouri mineral localities, pp. 750-753; Iron, pp. 16 and 46-47; Lead, p. 110; Coal, p. 272; Copper, p. 69; Mineral waters, p. 684; Natural gas, p. 495.

143

DAY, D. T.—Mineral Resources of the United States. Calendar Year 1888. David T. Day, Chief of Division of Mining Statistics and Technology. Dept. of the Interior. U. S. Geological Survey. J. W. Powell, Director. Washington, 1890.

This volume contains the following:

Brick production, pp. 581, 585; Cement from natural rock, p. 551; Coal, pp. 171, 199, 200, 285-289; Coke, pp. 395, 397, 398, 400, 404, 405, 407, 411-412; Iron, pp. 14, 23; Lime, pp. 555, 556; Limestone, p. 540; Mineral Springs, pp. 627, 630; Spelter, p. 92; Steel, p. 14; Structural material, p. 528.

144

FEATHERSTONHAUGH, G. W.—Geological report of the Examination made in 1834 of the Elevated Country between the Missouri and Red Rivers. By G. W. Featherstonhaugh, U. S. Geologist. Washington, 1835. 97 pp.

145

FOSTER, J. W. AND WHITNEY, J. D.—Report on the Geology of the Lake Superior Land District: by J. W. Foster and J. D. Whitney, United States Geologists. Part II. The Iron Region, together with the General Geology. 37 plates, 3 maps. Washington, 1851. Special Session, March, 1851. Executive No. 4. Plates. 406 pp.

An account of the Iron Ores of Missouri is given on pages 61-63.

146

HALL, J.—Observations on the Carboniferous Limestone of the Boundary Survey Collections, and its relations with the Carboniferous Limestones of the Mississippi Valley. By James Hall of Albany, New York. 4 pp. <Report of the United States and Mexican Boundary Survey. Vol. I, Part II: pp. 122-125, 1857. Quarto.

147

HALL, J.—Letter from Prof. James Hall of New York, containing observations on the geology and palæontology of the country traversed by the expedition, and notes upon some of the fossils collected on the route. <Exploration and Survey of the Valley of the Great Salt Lake of Utah, including a reconnoissance of a new route through the Rocky Mountains. By Howard Stansbury, Washington, 1853. Appendix E. 399-414.

It would seem from the letter that the specimens below named were collected on the Kansas side of the river, but the locality given in the descriptions would show them to be from the Missouri side of the river, and in one case the

statement is expressly made that the locality was on the east side. All the species are from limestone of the Carboniferous period from the Missouri river 'near,' 'above' or 'below' Weston, which is in Platte county, Missouri.

Spirifer triplicata, page 410, Pl. IV, Fig. 5, a, b, c.

Nucula arata, page 413, Pl. II, Fig. 5, a, b.

Pleurotomaria corunula, page 413, Pl. II, Fig. 6, a, b, c, d.

Productus (sp. indet.) page 411, Pl. III, Fig. 4.

Terebratula subtilita, page 409, Pl. IV, Fig. 1, a, b, 2, a, b.

Spirifer hemiplicata, page 409, Pl. IV, Fig. 3, a, b.

The following are also figured and redescribed :

S. octoplicatus? Sowerby (*Spirifer Kentuckyensis*, Shum.), page 409, Pl. IV, Fig. 4, a, b.

Chonetes variolata, DeKoninck, page 410, Pl. III, Fig. 1, a, b.

Productus costatus (?), Sowerby, page 411, Pl. III, Fig. 2.

148

HUMPHREYS, A. A. AND ABBOT, H. L.—Report upon the Physics and Hydraulics of the Mississippi River, to the Bureau of Topographical Engineers, War department. By Capt. A. A. Humphreys and Lieut. H. L. Abbot. J. B. Lippincott & Co., Phil., 4to. 456 pp. and app., 146 pp., maps and charts.

149

HUMPHREYS, A. A. AND ABBOT, H. L.—Report upon the Physics and Hydraulics of the Mississippi river, etc. Reprinted with Additions. Washington, 1876. 4to. xxiii and 691 pp.

This is No. 13 of the Professional Papers of the Corps of Topographical Engineers of the U. S. Army. It contains the geology of the banks of the river.

150

LEWIS AND CLARKE.—Travels to the Source of the Missouri River and across the American Continent to the Pacific Ocean, performed by order of the Government of the United States in the years 1804, 1805 and 1806. By Captains Lewis and Clarke; published from the official report, and illustrated by a map of the route and other maps. London: Printed for Longman, Hurst, Rees, Orme & Brown. Paternoster Row. 1814. Quarto.¹

151

LONG, S. H.—Account of an expedition from Pittsburg to the Rocky Mountains, performed in the years 1819 and 1820, under command of Major S. H. Long. Philadelphia. 1823. The Atlas accompanying it was issued in 1822.

¹Dr. Elliott Cones, U. S. A., in Bulletin No. 6 of the U. S. Geological and Geographical Survey of the Territories, gives the bibliography of fifteen other editions or rewritings of this work, and two editions of the President's Message transmitting it to Congress.

152

MARCOU, JULES AND J. B.—*Mapoteca Geologica Americana. A Catalogue of Geological Maps of America (North and South) 1752-1881.* In geographic and chronologic order. By Jules Marcon and John Belknap Marcou. Washington: Government Printing office, 1884. 184 pp.

This is Bulletin No. 7 of the U. S. Geological Survey.

153

NICOLLET, I. N.—Report intended to illustrate a map of the Hydrographical Basin of the Upper Mississippi River, made by I. N. Nicollet while in employ under the Bureau of the Corps of Topographical Engineers. Feb. 16, 1841.—Ordered to be printed, and 200 additional copies for the use of the Senate. Washington: Blair & Riven, Printers. 1843. 168 pp.

Information is given in regard to the rocks of the Mississippi and Missouri rivers.

154

OWEN, D. D.—Description of the Carboniferous Rocks of Iowa, including that of a Coal-field west of the Mississippi, lying partly in Iowa and partly in Missouri, the extent and limits now for the first time defined in this Report, and laid down on the large Geological Map accompanying it; with descriptions of minute, connected sections, passing in two directions through the heart of this Coal-field; one series along the Valley of the Missouri river; and the other series up the valley of the Des Moines. <Report of a Geological Survey of Wisconsin, Iowa and Minnesota; and incidentally of a Portion of Nebraska Territory. By David Dale Owen. Phil. 1852. 410.

The above sub-title is Chap. III, pages 16-164.

155

WILLIAMS, A. *Mineral Resources of the United States.* Albert Williams, Chief of Division of Mining Statistics and Technology.

THIS THE FIRST VOLUME, for 1892, is by Albert Williams, Jr. It contains the following Missouri reports:

Coal of Missouri, pp. 45-61; Lead, p. 222; Nickel of Mine La Motte, p. 602; Missouri Copper, p. 224; Lead and Zinc region of Southwest Missouri, by F. A. Clark, pp. 265-272; Other minerals and mineral substances of industrial importance, reported by John C. Smock; pp. 665-712.

156

WILLIAMS, A. Mineral Resources of the United States. Calendar years 1883 and 1884. Albert Williams, Jr., Chief of Division of Mining Statistics and Technology. Dept. of the Interior. U. S. Geological Survey. J. W. Powell, Director. Washington, 1883.

This volume has: Coal, pp. 51-52; Cobalt, pp. 545-546; Copper, p. 343; Iron ore, pp. 288-270; Lead, pp. 425-427; Lithographic stone, p. 935; Mineral waters, pp. 982-983; Salt, p. 843; Tin, p. 602; Tungsten, p. 574; Zinc, pp. 475-476.

THE UNITED STATES CENSUS REPORT FOR 1880. 4to.

(Alphabetical.)

157

BROADHEAD, G. C.—Missouri, [Building Stones of.] By G. C. Broadhead. <Report on the Building Stones of the United States and Statistics of the Quarry Industry for 1880. Part of Vol. X, pp. 265-274.

This gives a general geological section of the State and a description of the building stone of the different formations.

The above volume also contains a table showing the amount and kinds of rocks quarried in Missouri, at pp. 94-97.

158

CHAUVENET, W. M.—Notes on the Samples of Iron Ore collected in Missouri. By W. M. Chauvenet. <Vol. XV, pp. 403-420.

Many maps, sections and sketches of Missouri mines are given.

159

ELDRIDGE, G. H.—The Industries of the Base Metals (Lead, Zinc and Copper) in the Census Year. By George H. Eldridge. <Vol. XV, pp. 804-830.

160

HILGARD, E. W.—Report on Cotton Production in the United States. By Eugene W. Hilgard, Ph. D. <Vol. V.

This contains a map showing the geology of that part of the State where cotton is raised; also descriptions of it in the text.

161

KILLEBREW, J. B.—Report on the Culture and Curing of Tobacco in the United States. By J. B. Killebrew, Special Agent. <Vol. III.

Chapter x, pp. 94 to 102 relate to Missouri, and the author acknowledges indebtedness to Prof. Swallow for a description of the soils of Missouri, with their geological derivation.

162

LOUGHRIDGE, R. H.—Report on Cotton Production in the State of Missouri, with a brief description of the agricultural features of the State in general, and especially of the cotton producing counties. By R. H. Loughridge, Ph. D., Special Agent. 31 pp. <Vol. V, pp. 493-529.

163

PECKHAM, S. F.—Production, Technology and Uses of Petroleum and its Products. By S. F. Peckham. <Vol. X.

The report notices Bitumen in Missouri, page 20, and Petroleum in Missouri, page 28.

164

PRIME, F.—The Coals of the United States. By Frederick Prime, Jr., Ph. D. <Vol. XV, pp. 603-617.

The "Missouri Coal Field" is disposed of in a single short paragraph at page 616.

165

PORTER, D.—Report of the Water-Power of the Region Tributary to the Mississippi river on the West, below Dubuque, Io. By Dwight Porter, Ph. D. <Vol. XVII.

This contains much relating to the geology of the Missouri streams.

166

PUMPELLE, R.—Report on the Mining Industries of the United States. Geographical and Geological Distribution of the Iron Ores of the United States. By Raphael Pumpelly. <Vol. XV, pp. 3-36.

This has a map, sections and descriptions of the Missouri iron ores.

167

PUMPELLE, R.—Directory of Mines and Metallurgical Establishments East of the 100th Meridian, and of the Mines of Bituminous Coal and Lignite in the Western States and Territories. <Vol. XV.

Coal Mines of Missouri, pp. 896-897; Iron Mines, pp. 948-949; Lead and Zinc Mines, pp. 978-979; Barytes, p. 983; Nickel and Cobalt, p. 987.

BULLETIN, MISSOURI GEOLOGICAL SURVEY.

AMERICAN STATE PAPERS.

(*Chronological.*)

168

DESCRIPTION OF THE LEAD MINES IN UPPER LOUISIANA. Communicated to Congress by Amos Stoddard, Captain, First Civil Commandant of Upper Louisiana, dated November 8, 1804. 2nd Session, 8th Congress. No. 103. <Vol. I, pp. 188-191.

This describes the number, extent, situation and names of the lead mines, and gives manner of working the mines and smelting the ore.

169

LEAD MINES IN THE LOUISIANA TERRITORY. Communicated to the House of Representatives, June 25, 1812. 1st Session, 12th Congress. No. 204. <Vol. II, page 380.

This is a report on the lead mines in the northern part of the territory, or what is now Missouri, by Edward Tiffin.

170

LEAD MINES AND SALINES. Report of Alexander McNair, Register for the District of St. Louis, Missouri. 2nd Session, 14th Congress. No. 248. <Vol. III, pp. 235-238.

This document also has "Lead Mines and Salines. Report of Moses Austin, Esq., dated Mine a Burton, Washington county, Missouri Territory." <Same volume, page 238 and map.

The title of the map is: "Sketch of the Lead Mine District in Washington county, Missouri Territory. General Land Office, Dec. 10th, 1816. Joseph Meigs." Scale 2 ms. to 1 inch.

171

LEAD MINES IN MISSOURI. Communicated to the Senate May 7, 1822. 1st Session. 17th Congress. No. 364. <Vol. III, pp. 492-496.

This contains a report from George Bomford, Lieut.-Colonel of the Ordnance Department, in which the lead mines of Missouri are described.

172

SALT SPRINGS AND LEAD AND COPPER MINES. Communicated to the House of Representatives March 30, 1824. 1st Session. 18th Congress. No. 406. <Vol. III, pp. 572-614.

This contains a list of the Salt Springs in Missouri on page 572; also Minerals in Missouri, with history, statistics and titles of the lead mines, on pp. 575-614. The latter includes the report of Moses Austin on the lead mines in Ste. Genevieve, Washington and St. Louis counties, on pp. 609-613.

173

LEAD MINES AND SALT SPRINGS. Dated Feb. 7, 1826. 1st Session. 19th Congress. No. 467. <Vol. IV, pp. 369-379.

This is an extended report by Lt.-Col. Bomford, on the manner of mining, kind of ores, situation and extent of mining country in Missouri, with an account of the topography of the country; also Abstract of Leases of Lead Mines in Missouri, by George Graham.

174

LEAD MINES AND SALT SPRINGS IN MISSOURI. Communicated to the Senate by the Chairman of the Committee on Public Lands, December 27, 1826. 2nd Session. 19th Congress. No. 507. <Vol. IV, pp. 590-591.

This contains lists of lands reserved from sale on account of salt springs.

175

LEAD MINES. Communicated to the House of Representatives Jan'y 7, 1828. 1st Session, 20th Congress. No. 568. <Vol. V, pp. 4-6.

This is a report by Lt.-Col. George Bomford on the mines of Missouri.

176

SALE OF THE LEAD MINES IN MISSOURI. Communicated to the House of Representatives January 30, 1828. 1st Session. 20th Congress. No. 593. <Vol. V, pp. 76-77.

178

APPLICATION OF MISSOURI for authority to sell her school lands and salines, and for the sale of the Mineral Lands within her limits. Communicated to the Senate, Jan. 5, 1829. Memorials of the Legislature of Missouri. December 11, 1828. <Vol. V, pp. 199-200.

MISCELLANEOUS DOCUMENTS OF THE UNITED STATES
CONGRESS. .

(*Chronological*)

179

MESSAGE FROM THE PRESIDENT OF THE UNITED STATES, transmitting the information required by a resolution of the House of Representatives respecting the Lead Mines of Missouri. May 7, 1822. Printed by order of the Senate of the United States. Washington: 1822. 19 pp.

180

LEAD MINES—ILLINOIS AND MISSOURI. Message from the President of the United States, transmitting the information required by a Resolution of the House of Representatives, of 8th May last, in relation to the Lead Mines belonging to the United States, in the States of Illinois and Missouri. Dec. 8, 1826. Read, and laid upon the table. Washington: 1826. 19th Congress, 2nd session. [Doc. No. 7.] Executive. 13 pp.

181

STATEMENT in relation to the Lead Mines and Salt Springs in Missouri. Laid before the Senate by the Chairman of the Committee on Public Lands. December 27, 1826. Printed by order of the Senate of the United States. Washington: 1826. 19th Congress, Second Session. [9.] 6 pp.

182

LEAD MINES. Letter from the Secretary of War, transmitting the information required by a resolution of the House of Representatives of the 2d inst. in relation to the Lead Mines of the United States. January 7, 1828. Read, and referred to the Committee on the Public Lands. Washington: 1828. 20th Congress, 1st Session, Ho. of Reps. War Dept. [Doc. No. 45.] 10 pp.

183

REPORT FROM THE SECRETARY OF WAR in relation to Lead and Lead Mines in Missouri. April 8, 1828. Printed by order of the Senate of the United States. Washington, 1828. 20th Congress, 1st Session. [169.] 7 pp. and 2 folded pages.

184

MESSAGE FROM THE PRESIDENT of the United States, transmitting a report of the Secretary of War, and of the Commissioner of the General Land Office, in relation to the Salt Springs and Lead and Copper Mines. March 30, 1824. Read. Ordered that it lie upon the table. Washington, 1824, 147 pp. 18th Congress, 1st Session. [128.]

185

GEOLOGICAL SURVEY.—Memorial of the Legislature of Missouri, relative to a Geological Survey of that State. Feb. 29, 1849. 30th Congress, 2d Session, Ho. of Reps., Miscellaneous, No. 53, 3 pp.

186

BARNEY, J.—Survey of route from St. Louis to Fulton, made in 1850 by the Bureau of Topographical Engineers, War Dept. By Joshua Barney, C. E.*

187

BARNEY, J.—Report of a Survey from St. Louis to the Big Bend of Red River. By Joshua Barney. Washington. 1852.*

188

JOHNSTON, J. E.—Reconnaissance of a railroad route from Neosho, Mo., to the Rio Grande, by Lt. Col. Joseph E. Johnston. House, Ex. Doc., No. 103. 1st Session, 35th Congress.*

189

NORTHERN BOUNDARY OF MISSOURI. December 31, 1842. Referred to the Committee on the Territories. 27th Congress, 3d Session. Ho. of Reps., Doc. No. 38, 43 pp

190

OWEN, D. D.—Report of a geological exploration of a part of Iowa, Wisconsin and Illinois in 1839. By David Dale Owen. 1840.*

Message President of the United States concerning the Mineral lands of the United States. 1st Sess. 26th Cong. H. R. Ex. Doc. No. 239, pp. 9-115.*

Also republication with slight revision in 1844 in Senate Doc. No. 407 of 28th Congress.*

This is one of the earliest publications proposing the geological classification of the Missouri rocks.

191

OWEN.—Report on Chippewa Land District.*

Contains numerous sections of Carboniferous limestone in Mississippi and Missouri Valleys.

192

MINERAL LANDS.—Report of the Colonel of Ordnance in relation to the Mineral lands of Missouri. Washington, 1836.*

193

BROADHEAD, G. C.—Missouri—its Mineral Resources. 8 pp. <Report of U. S. Commissioner of Statistics, 1889, pp. 461-468.

194

JAMISON, J.—Report on the Coal Fields and Coal Mines on the Western Waters. By J. Jamison. Washington. 1852.

This describes the cannel coal of Callaway county.

195

JOHNSON, W. R.—A Report to the Navy Department of the United States, on American Coals applicable to steam navigation and other purposes. By Walter R. Johnson. Washington. 1844. Senate. 28th Congress. 1st Session. 386.

Contains an analysis of coal from the Osage river, on page 539.

196

PIKE, Z. M.—Account of Expeditions to the Sources of the Mississippi and through the Western Parts of Louisiana, to the Sources of the Arkansaw, Kans, LaPlatte and Piere Juan Rivers: Performed by order of the Government of the United States During the years 1805, 1806 and 1807. And Tour through the Interior Parts of New Spain, when Conducted through these Provinces, by order of the Captain-General, in the year 1807. By Major Z. M. Pike. Phila., 1810; 490 pp., 6 maps, 3 folded tables. Portrait.

197

PIKE, Z. M.—Exploratory Travels through the Western Territories of North America: Comprising a Voyage from St. Louis, on the Mississippi, to the Source of that river, and a Journey through the Interior of Louisiana, and North-eastern provinces of New Spain. Performed in the years 1805, 1806 and 1807, by Order of the Government of the United States. By Zebulon Montgomery Pike,

Major 6th Regt., United States Infantry. London: Printed for Longman, Hurst, Rees, Orme and Brown. Paternoster-Row, 1811. 4°, 436 pp.

198

WHITE, C. A.—Contributions to Invertebrate Paleontology No. 8: Fossils from the Carboniferous Rocks of the Interior States. By C. A. White, M. D. <Twelfth Annual Report of the United States Geological and Geographical Survey for the year 1878, by F. V. Hayden. Washington. 1883; pp. 155-171. 4 plates.

The following species are described:

Chonophyllum Sedaliense, page 157, Pl. 39, Fig. 3a.

Michilinia ? placenta, page 157, Pl. 39, Figs. 1a, b, c, d.

M. expansa, page 158, Pl. 39, Figs. 2a, b.

Lithostrotion microstylum, page 159, Pl. 40, Fig. 7a, all from the Chouteau Limestone (Kinderhook division Subcarboniferous Series), Sedalia.

Naticopsis monilifera, page 168, Pl. 42, Figs. 3a, b, c, Upper Coal Measures, Pleasant Hill.

Pleurotomaria Broadheadi, page 169, Pl. 42, Figs. 1a, b.

Conularia crustula, page 170, Pl. 42, Fig. 4a, both from the Coal Measures, Kansas City.

The following are noticed as found in Missouri:

Zaphrentis calceola, W. & W. Chouteau limestone at Sedalia.

Rhynchonella Ottumwa, White, St. Louis limestone, various localities.

199

WISLIZENUS, A.—Memoir of a tour to Northern Mexico, connected with Col. Doniphan's Expedition, in 1846 and 1847. By A. Wislizenus, M. D.; [with a scientific appendix and three maps.] (....) Washington: Tippin & Struper, Printers. 1848. Senate Mis. Doc., No. 26, 1st Session, 30th Congress.

This tour was commenced at St. Louis in 1846.

200

WOODWARD, R. S.—Latitudes and longitudes of certain points in Missouri, Kansas and New Mexico, by Robert Simpson Woodward. <United States Geological Survey, J. W. Powell, Director. Bulletin 49, Washington, 1888. 133 pp.

SMITHSONIAN INSTITUTION, ANNUAL REPORTS.

201

BROADHEAD, G. C.—Prehistoric Evidences in Missouri, by G. C. Broadhead. <Report 1879, pp. 350-359. 11 Figs.

Human foot-prints are noticed on pp. 357-359, and accounts of several such Missouri specimens are given.

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

202

LEIDY, J.—Memoir on the Extinct Species of American Ox. By Joseph Leidy, M. D. 20 pp., 5 plates. <Vol. V, Washington, 1853.

Mentions specimens from New Madrid and from Benton county.

UNITED STATES AGRICULTURAL REPORTS.

203

DODGE.—Mineral Fertilizers of the Mississippi valley. 35 pp. and 3 Geological maps. <Report for 1869, page 548.

The geology and fertilizers of Missouri are given on pp. 560-562, and one of the maps includes the State.

204

SWALLOW, G. C.—Grape-culture in Missouri. By G. C. Swallow. 6 pp. <Report for 1857, page 232.

PART III.

Publications of State Geological Surveys other than that of Missouri.

REPORTS OF THE ARKANSAS GEOLOGICAL SURVEY.

205

OWEN, D. D.—First Report of a Geological Reconnoissance of the Northwestern Counties of Arkansas, made during the years 1857 and 1858. By David Dale Owen. Little Rock. 1858.

The lead bearing formations of Missouri are described on pp. 105-109.

REPORTS OF THE ILLINOIS GEOLOGICAL SURVEY.

206

MEEK, F. B. AND WORTHEN, A. H.—Descriptions of Invertebrates from the Carboniferous System. By F. B. Meek and A. H. Worthen. <Vol. II, pp. 143-423. 1866.

The following Missouri localities are given :

Sphenopterium enorme, M. & W., page 148, Pl. 14, Figs. 1a, 1b, Kinderhook group, Clarksville.

Rhynchonella Missouriensis, Shumard, page 153, Pl. 14, Figs. 4a, 4b, Kinderhook group, Chouteau Springs, and numerous other localities.

Spirifer Cooperensis, Swallow, page 155, Pl. 14, Figs. 5a, 5b, same as last.

Strepatorollus lens, Hall, page 159, Pl. 14, Figs. 7a, 7b, Chouteau limestone in Moniteau and adjoining counties.

Nautilus digonus, M. & W., page 163, Pl. 14, Figs. 9a, 9b, 9c, 9d, from the Kinderhook group at several places in Central Missouri.

Oligoporus Danz, M. & W., page 249, Pl. 17, Fig. 8, from the Keokuk at Fenton, St. Louis county.

Syntrielasma hemiplicata, Hall, page 323, Figs. 37, a and b, Upper Coal Measures, Northern Missouri.

Coscium plumosum, Prout, page 414, Pl. 22, Figs. 3, 3a, lower beds of St. Louis group, Barretts Station, St. Louis county.

Cyclopora fungia, Prout, page 419, Pl. 22, Figs. 9, 9a, 9b, Keokuk group, St. Francisville.

MEEK, F. B. AND WORTHEN, A. H.—Paleontology of Illinois. <Vol. III, pages 289–565. 1868.

Describes the following species :

Striatopora Missouriensis, page 369, Pl. 7, Fig. 4, from limestone of age of "Shaly limestone," of the New York Lower Helderberg division of the Upper Silurian, Bailey's Landing, Perry county.

Zygospira subconcava, page 380, Pl. 7, Figs. 1a, b, c, d, from limestone of the age of the Delthyris shale of the N. Y. Lower Helderberg, Bailey's Landing, Perry county.

Platyceras subundatum, page 387, Pl. 7, Figs. 13a, b, 14a, b, from limestone representing "Shaly limestone," same locality.

The following localities are also given :

Comarocystites Shumardi, M. & W., page 292, Pl. I, Figs. 1a, b.

C. Shumardi var. *obconicus*, M. & W., page 294, Pl. I, Figs. 2a, b, both from Trenton division of the Lower Silurian at Cape Girardeau.

Edriocrinus pocilliformis, Hall, page 370, Pl. 7, Figs. 5a, b. "Shaly Limestone," Bailey's Landing.

Orthis hybrida, Sowerby? page 371, Pl. 7, Figs. 7a, b, c, d, same as last.

O. subcarinata, Hall, page 373, Pl. 7, Figs. 6a, b, c, d, same as last.

Strophomena (Strophodonta) cavumbona, Hall? page 374, Pl. 7, Figs. 10a, b, from Delthyris Shaly limestone, Bailey's Landing.

Merista laevis, Vanuxem? page 376, Pl. 7, Figs. 8a, b, c, same as last.

Trematospira? imbricata, Hall, page 381, Pl. 7, Figs. 2a, b, c, d, e, same as last.

Cyrtina Dalmani, Hall, page 383, Pl. 7, Figs. 3a, b, same as last.

Spirifer perlamellosus, Hall, page 384, Pl. 7, Figs. 9a, b, same as last.

Platyceras spirale, Hall, page 389, Pl. 7, Figs. 12a, b, c, Lower Helderberg, Bailey's Landing.

P. (Orthonychia) pyramidatum, Hall? page 389, Pl. 7, Fig. 11, same as last.

Acidaspis hamata, Conrad, page 390, Pl. 7, Fig. 16, same as last.

NEWBERRY, J. S. AND WORTHEN, A. H.—Descriptions of New Species of Vertebrates, mainly from the Sub-carboniferous Limestone and Coal Measures of Illinois. By J. S. Newberry and A. H. Worthen. <Vol. II, pages 9–141. 1866.

Describes the following species :

Cladodus spinosus, page 22, Pl. I, Figs. 3, 3a.

C. ferox, page 26, Pl. I, Figs. 11, 11a.

Ctemanthus tenacanthus? costatus, page 120, Pl. XII, Fig. 2.

C. gracillimus, page 126, Pl. XIII, Fig. 3.

Dactylodus princeps, page 45, Pl. III, Figs. 6, 6a, 6b.

Deltodus rhomboldeus, page 100, Pl. IX, Fig. 8.

Homacanthus gibbosus, page 113, Pl. XII, Fig. 1.

H.? rectus, page 115, Pl. XII, Fig. 6.

Leptocanthus? occidentalis, page 116, Pl. XII, Fig. 2.

Orodus plicatus, page 63, Pl. IV, Fig. 5, all from the St. Louis Limestone at St. Louis.

Helodus consolidatus, page 87, Pl. VI, Figs. 1, 1a, 2, 2a, from the Keokuk Limestone, St. Francisville.

209

NEWBERRY, J. S. AND WORTHEN, A. H. Descriptions of Fossil Vertebrates. By J. S. Newberry and A. H. Worthen. <Vol. IV, pages 343-374. 1870.

The following species are described:

Cladodus ischypus, page 354, Pl. IV, Figs. 6, 6a.

C. elegans, page 354, Pl. IV, Fig. 9.

Polyrhizodus Littoni, page 357, Pl. IV, Figs. 10, 10a.

Sandalodus crassus, page 369, Pl. IV, Figs. 3, 3a, all from the St. Louis Limestone, St. Louis.

Deltodus Littoni, page 367, Pl. IV, Figs. 8, 8a, from Lower Carboniferous Limestone, Boone county.

Dalmanites tridentiferus, Shumard, page 391, Pl. 7, Fig. 16, Shaly Limestone, Bailey's Landing.

Platyceras ? reversum, Hall, page 508, Pl. 15, Figs. 4a, b and annexed cut, Burlington group, at Boonville.

Productus magnus, M. & W., page 528, Pl. 20, Figs. 7 a, b, c, Keokuk of St. Genevieve county.

210

NEWBERRY, J. S. AND WORTHEN, A. H. Descriptions of Invertebrates from Carboniferous System. <Vol. V, pp. 321-619. 1873.

This describes:

Myalina St. Ludovici, Worthen, page 540, Pl. 22, Fig. 3, from the St. Louis Limestone at St. Louis.

It also has description and figure of

Conularia Missouriensis, Swallow, page 541, Pl. 22, Fig. 5.

211

WORTHEN, A. H.—Geological Survey of Illinois. By A. H. Worthen. <Vol. I. 1866.

In Chapter III, on Sub-carboniferous Limestone, there are frequent references to the groups of this division in Missouri.

212

ST. JOHN, O. AND WORTHEN, A. H.—Descriptions of Fossil Fishes. By Orestes St. John and A. H. Worthen. <Vol. VI, page 243. 1875.

The following Missouri species are described:

Cladodus eccentricus, page 272, Pl. 4, Fig. 4.

C. englypheus, page 273, Pl. 14, Figs. 1-3.

Desmiodus tumidus, page 339, Pl. Xa, Figs. 7-9.

D. castelliferus, page 341, Pl. Xa, Figs. 10, 11.

Venustodus Leidy, page 350, Pl. IX, Figs. 1-4.

- Harpacodus occidentalis*, page 335, Pl. Xa, Fig. 2.
Chomatodus incrassatus, page 339, Pl. X, Fig. 18.
Lisgodus selluliformis, page 366, Pl. Xa, Fig. 16.
Tanaodus Prænuntius, page 371, Pl. XI, Figs. 6-10.
T. sculptus, page 373, Pl. XI, Figs. 20-23.
Polyrhizodus amplius, page 387, Pl. XIII, Fig. 13.
Petalorhynchus pseudosagittatus, page 405, Pl. XII, Figs. 1-4.
P. distortus, page 406, Pl. XII, Figs. 7, 8.
Potodus quadratus, page 410, Pl. XIII, Figs. 6, 7.
Ctenacanthus pugiunculus, page 430, Pl. XXI, Fig. 9.
Asteroptychius St. Ludovici, page 437, Pl. XVI, Figs. 3, 4.
Geisacanthus stellatus, page 440, Pl. XXI, Fig. 10.
Drepanacanthus reversus, page 456, Pl. XIX, Figs. 5, 6.
Eriamacanthus McCoyanus, page 461, Pl. XXII, Figs. 1-5.
Amacanthus gibbosus, page 464, Pl. XXII, Fig. 6.
Marracanthus rectus, page 466, Pl. XXII, Figs. 7-9.
Gampsacanthus typus, page 472, Pl. XXII, Fig. 12.
G. squamosus, page 473, Pl. XXII, Fig. 13.
Lecracanthus unguiculus, page 476, Pl. XXII, Figs. 10, 11.
Oracanthus consimilis, page 478, Pl. XXII, Fig. 15, all from the St. Louis Limestone at St. Louis.
Lambodus costatus, page 280, Pl. V, Fig. 3.
Desmiodus ? ligoniformis, page 342, Pl. Xa, Figs. 12-14.
D ? flabellum, page 343, Pl. Xa, Fig. 15.
Lisgodus curtus, page 364, Pl. Xa, Figs. 20-22.
Polyrhizodus Williamsi, page 384, Pl. Xa, Fig. 23; Pl. XIII, Fig. 11.
Physonemus parvulus, page 453, Pl. XVIII, Figs. 11, 12.
Gampsocanthus ? latus, page 474, Pl. XXII, Fig. 14, all from the Keokuk at Boonville.
Venustodus tenuicristatus, page 348, Pl. IX, Figs. 19-24, from the Keokuk at St. Francisville and Boonville.
Ctenacanthus Keokuk, page 427, Pl. XV, Figs. 8, a, b, c, d, e, from the Keokuk at Boonville and Legrande.
C. excavatus, page 428, Pl. XV, Figs. 4, 5, from the Keokuk at Legrande.
Batacanthus baculiformis, page 469, Pl. XXI, Figs. 4-8, from the Keokuk at Legrande and St. Francisville.
Lambodus calceolus, page 281, Pl. V, Fig. 5, from the Keokuk at Legrande.
Chomatodus parallelus, page 358, Pl. Xa, Figs. 3, 4, from the Warsaw beds at Boonville.

ST. JOHN, O. & WORTHEN, A. H.—Palæontology of Illinois. Descriptions of Fossil Vertebrates. <Vol. VII. 1883.

The following Missouri species are described :

- Cochliodus VanHornii*, page 120, Pl. VII, Figs. 1-10.
C. obliquus, page 126, Pl. VII, Fig. 17.
Copodus VanHornii, page 229, Pl. XX, Figs. 2, 3.
Deltodopsis St. Ludovici, page 161, Pl. XI, Figs. 2-6.
Deltodus parvus, page 151, Pl. IX, Figs. 1-5.
Deltoptychius expansus, page 98, Pl. V, Figs. 9-13.

- Physonemus falcatus*, page 252, Pl. XXIV, Fig. 6.
Pœcilodus St. Ludovici, page 132, Pl. VIII, Figs. 8, 12.
Psammodus plenus, page 213, Pl. XVI, Figs. 1-4; Pl. XVII, Figs. 1-4.
Pæphodus latus, page 72, Pl. II, Figs. 1, 3.
Vaticinodus ? simplex, page 84, Pl. IV, Figs. 22-26.
Xystrodus imitatus, page 180, Pl. VIII, Fig. 2, all from the St. Louis Limestone at St. Louis.
Deltodus cinctulus, page 146, Pl. IX, Figs. 6, 7, from the Warsaw beds at Barrett's Station.
Deltotrychius Wachsmuthi, page 93, Pl. V, Figs. 1-5, from the Keokuk at Boonville.

The following species are also figured :

- Ctenacanthus gracillimus*, N. & W.
Drepanacanthus reversus, St. J. & W.
Oracanthus vetustus, Leidy.
Sandalodus spatulatus.
Stenopterodus parvulus, N. & W. all from the St. Louis Limestone at St. Louis.
Orthopteroodus carbonarius, N. & W. Upper Coal Measures of Mo.
Sandalodus laevisimus, N. & W. Keokuk at Boonville.

REPORTS OF THE IOWA GEOLOGICAL SURVEY.

214

HALL, J.—Report on the Geological Survey of the State of Iowa. By James Hall. <Vol. I, Part I. 1858.

There are numerous references to the geology of Missouri in accounts of the Chemung Group, Burlington Limestone, St. Louis Limestone, Coal Measures, and in many other parts of the work.

215

HALL, J.—Report on the Geological Survey of the State of Iowa. By James Hall, State Geologist. <Vol. I, Part II. Palæontology. 1858.

Describes the following species :

- Athyris incrassatus*, page 600, Pl. XII, Fig. 6, from the Burlington Limestone at Hannibal.
Archæocidaris Wortheni, page 700, Pl. XXVI, Figs. 4a-g, from the St. Louis Limestone near St. Louis.
Forbesiocrinus Giddingsi, page 633, Pl. XVII, Figs. 2, 4, from the Keokuk Limestone ? at Boonville.
F. Shumardianus, page 671, Pl. XVII, Fig. 1, from the St. Louis Limestone at St. Louis.
Orthis Michelina var *Burlingtonensis*, page 596, Pl. XII, Figs. 4a, b, from the Burlington Limestone at Hannibal.

O. Swallovi, page 597, Pl. XII, Figs. 5a, b, from the Burlington Limestone at numerous localities.

Pentremites bipyramidalis, page 607, Pl. XV, Fig. 2, from the Keokuk Limestone, State of Missouri.

Productus pyxidatus, page 498, Pl. III, Figs. 8a-c, from calcareous shale and limestone of the age of the Hamilton group at Louisiana.

P. Shumardianus, page 499, Pl. III, Fig. 9, and Pl. VII, Fig. 1, same formation as last at Clarksville.

P. ovasus, page 674, Pl. XXIV; Fig. 1, from the St. Louis Limestone at St. Louis.

Poteriocrinus Missouriensis, page 669, Pl. XVII, Figs. 7 a, b, from the St. Louis Limestone at St. Louis.

Platycrinus Saræ, page 673, Pl. XVII, Fig. 4, from the St. Louis Limestone near St. Louis.

Scaphiocrinus dactyliiformis, page 670, Pl. XVII, Fig. 6, from the St. Louis Limestone, St. Louis.

Synbathocrinus Swallovi, page 672, Pl. XVII, Figs. 8, 9, from the same.

The following species are given as found in Missouri, a part of the figures being of Missouri specimens. All of the species are figured except the last:

Lithostroton mamillare, E. & H.

Orthis Vanuxemi, Hall.

Productus marginicinctus, Prout.

P. costatus var.

Pleurotomaria sphaerulata, Con.

Spirifer Marionensis, Shum.

S. cameratus, Morton.

Terebratulula subtilita, Hall.

REPORTS OF THE OHIO GEOLOGICAL SURVEY.

216

MEEK.—A Report on some of the Invertebrate Fossils of the Waverly Group and Coal Measures of Ohio. <Vol. II. Part II. Palæontology. Columbus. 1875.

The following species, which have been described from Missouri, are compared with or made synonyms of other species in the Waverly group:

Allorisma Hannibalensis, Shum.

Avicula Cooperensis, Shum.

Grammysia Hannibalensis, Shum.

Spirifer (Crytia?) Hannibalensis, Swallow.

S. Osagensis, Swallow.

Spirigera Hannibalensis, Swallow.

See also:

Productus ——— .

Spirifer (Trigonotreta) opimus, Hall.

REPORTS OF THE PENNSYLVANIA GEOLOGICAL SURVEY

217

LESQUIREUX, L.—Description of the Coal Flora of the Carboniferous formations in Pennsylvania and throughout the United States. By L. Lesquereux. <Second Geological Survey of Pennsylvania. P. Vols. I and II, 1880, and Vol. III, 1884.

The following Missouri species are described :

- Alethopteris ambigua*, page 182, Pl. XXXI, Figs. 1-4, Clinton.
- Asterophyllites fasciculatus*, page 41, Pl. III, Figs. 1-4, Clinton.
- Callipteridium membranaceum*, page 172, Pl. XXVII, Fig. 4-8, Clinton.
- Conostichus Broadheadi*, page 15, Pl. B, Figs. 1-2, from shale near the base of the Coal Measures, Vernon county.
- C. prolifer*, page 16, Pl. B, Fig. 3, same locality.
- Cordaianthus dichotomus*, page 546, Pl. LXXXVI, Figs. 6, 6b, Clinton.
- Eremopteris Missouriensis*, page 295, Pl. LIII, Figs. 8, 8a, Clinton.
- Lepidodendron Brittii*, page 363, Pl. LXIII, Figs. 1, 2, Clinton.
- L. lanceolatum*, page 369, Pl. LXIII, Figs. 3-5a, Clinton.
- L. cyclostigma*, page 394, Pl. LXIII, Fig. 5, Clinton.
- L. scutatum*, page 369, Pl. LXIII, Figs. 6-6c, Clinton.
- Lepidophloios sigillarioides*, page 425, Pl. LXVIII, Figs. 8, 8a, Clinton.
- Neuropteris Missouriensis*, page 104, Pl. VIII, Figs. 5, 6, Clinton.
- Odontopteris sphenopteroides*, page 139, Pl. XXI, Figs. 3, 4, Clinton.
- Pecopteris Clinsoni*, page 251, Pl. XLII, Figs. 1-5b, Clinton.
- Rhacophyllum membranaceum*, page 312, Pl. LVIII, Figs. 1, 2, Clinton.
- R. spinosum*, page 320, Pl. LVIII, Figs. 4, 5, Clinton.
- R. hamulosum*, page 321, Pl. LVIII, Fig. 3, Clinton.
- Sordocladus ophioglossoides*, page 329, Pl. XLVIII, Fig. 11, Clinton.
- Sphenopteris Brittii*, page 277, Pl. LV, Figs. 2, 2b, Clinton.

The following species are also noticed, mostly from Clinton, and many of them have Missouri specimens figured :

- Alethopteris Serlii*, Brgt.
- Callipteridium Sullivanti*, Lesqx.
- Cordailes communis*, Lesqx.
- C. diversifolius*, Lesqx.
- Dictyopteris obliqua*, Bunb'y.
- Lepidozylon anomalum*, Lesqx.
- Megaphyllum Goldenbergii*, Weiss.
- Neuropteris angustifolia*, Brgt.
- N. Clarksonii*, Lesqx.
- N. cordata*, Brgt.
- N. dilatata*, Ll. & Hutt.
- N. Loschii*, Brgt.
- N. rarinervis*, Bunb'y.
- Pecopteris dentata*, Brgt.
- P. erosa*, Gutb.

- P. pennæformis*, Brgt.
Pseudoplectopteris irregularis, St.
Rhacophyllum filiciforme (Gutb.), Schp.
R. hirsutum, Lesqx.
R. fimbriatum, Lesqx.
R. lactuca, Sternb.
Sphenophyllum filiculme, Lesqx.
S. longifolium, Germ.
S. oblongifolium, Germ.
Sphenopteris Dubuissonis, Brgt.
S. Gavenhorstii, Brgt.
S. mixta, Schp.
S. (Hymen.) splendens, Lesqx.
S. (Hymen.) tridactylites, Brgt.
Taonurus Colletti, Lesqx.

PART IV.

Publications of Scientific Societies and Periodicals.

ALBANY INSTITUTE TRANSACTIONS.

218

HALL, J.—Descriptions of New Species of Fossils from the Carboniferous Limestones of Indiana and Illinois. By James Hall. 36 pp. <Vol. IV, page 1.

The fossils described are from Spergen Hill and Bloomington, Indiana. The different beds of the Sub-carboniferous are stated, and localities in Missouri and other parts of the West are given. This paper, with additions by Prof. Whitfield, was republished in Bulletin No. 3 of the American Museum of Natural History, New York.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE PROCEEDINGS.

219

HALL, J.—On the Carboniferous Limestones of the Mississippi Valley. By Professor James Hall, of Albany, N. Y. 19 pp. <10th Meeting, 1856, page 51.

220

KING, H.—Some Remarks on the Geology of the State of Missouri. By Dr. H. King, of St. Louis. 18 pp. <5th Meeting, 1851, page 182.

221

McADAMS, W.—A New Vertebrate from the St. Louis Limestone. By William McAdams, of Alton, Ill. Abstract, 1 page. <32nd Meeting, 1883, page 269.

222

MACFARLANE, J.—The "Earthquake" at New Madrid, Mo., in 1811, probably not an Earthquake. By James Macfarlane, of Towanda, Penn. Abstract, 2 pp. <32nd Meeting, 1883, page 220.

There is a discussion of this paper in "Science," Sept. 7, 1883.

223

OWEN, D. D.—Abstract of Introduction to the Final Report on the Geological Surveys made in Wisconsin, Iowa and Minnesota, etc. By D. D. Owen, M. D. 13 pp. <5th Meeting, 1851, page 119.

224

SPENCER, J. W.—Sand Boulders in the Drift, or Sub-aqueous Origin of the Drift in Central Missouri. By Prof. J. W. Spencer, University of Missouri, Columbia, Mo. Abstract. 1 page. <36th Meeting, 1887, page 220.

225

SWALLOW, G. C.—Explanations of the Geological Map of Missouri, and a Section of its Rocks. By Prof. G. C. Swallow, State Geologist of Missouri. 21 pp. 1 plate. <11th Meeting, 1857, page 1.

The paper refers to a map as accompanying it, but this was not found in the copies examined.

226

— Quaternary Deposits of Missouri. 19 pp. 1 plate. <11th Meeting, 1857, page 21.

227

— Grape Culture in Missouri. 15 pp. 1 plate. <12th Meeting, 1858, page 268.

228

— Remarks on the Geological Map and Section of the Rocks of Missouri. Abstract. 1 page. <20th Meeting, 1871, page 262.

229

TODD, J. E.—On the Annual Deposit of the Missouri River, during the Post-pliocene. By J. E. Todd, of Tabor, Iowa. Abstract. 5 pp. <26th Meeting, 1877, page 289.

230

TODD, J. E.—Richthofen's Theory of the Loess, in the Light of the Deposits of the Missouri. 9 pp. <27th meeting, Vol. XXVII, 1878, page 231.

231

TROWBRIDGE, S. H.—Remarks on the Classification and Distribution of Producti. By S. H. Trowbridge, of Glasgow, Mo. 12 pp. <30th Meeting, 1881, page 193.

AMERICAN CHEMICAL SOCIETY TRANSACTIONS.

232

WILLIAMS, C. P.—Analysis of Mine Water from the Lead Region of Southwest Missouri. By C. P. Williams. <Vol. I, page 179. [1877.]

AMERICAN EXCHANGE AND REVIEW.

233

EDITORIAL.—Mining and Metallic Production in the United States. pp. 13, 9, 9 and 10. <Vol. III, Nos. 3, 4, 5 and 6, April to July, 1863.

AMERICAN GEOLOGIST.

234

BROADHEAD, G. C.—The Geological History of the Ozark Uplift. By G. C. Broadhead. Read before the A. A. A. S., 1888. 8 pp. <Vol. III, No. 1, page 6. Jan., 1889.

235

— The Missouri River. 8 pp. <Vol. IV, No. 3, page 148. Sept., 1889.

236

CLAYPOLE, E. W.—The Story of the Mississippi-Missouri. By Dr. E. W. Claypole, Akron, O. 17 pp. <Vol. III, No. 6, page 361. June, 1889.

237

EDITORIAL.—Notice of article of J. W. Spencer in American Naturalist, on "Sand-boulders in the drift; or sub-aqueous origin of the drift in Central Missouri." 2 pp. <Vol I, No. 2, page 120. Feb. 1888.

238

HAWORTH, E.—A Contribution to the Archæan Geology of Missouri. By Erasmus Haworth. 38 pp. 1 pl. <Vol. I, Nos. 5 and 6, pages 287 and 382.

239

ROWLEY, R. R.—The Chouteau Group of Eastern Missouri. By R. R. Rowley. 6 pp. <Vol. III, No. 2, page 111. Feb. 1889.

240

—Observations on the Kinderhook Fossils. 2 pp. <Vol. III, No. 4, page 275. April, 1889.

AMERICAN INSTITUTE OF MINING ENGINEERS TRANSACTIONS.

241

BIRKINBINE, J.—Prominent Sources of Iron-Ore Supply. By John Birkinbine, Philadelphia, Pa. 14 pp. <Vol XVI, page 715. 1889.

242

BROADHEAD, G. C.—The Southeast Missouri Lead District. By Prof. G. C. Broadhead, Pleasant Hill, Mo. 7 pp. <Vol. V, page 100.

This was also published in the Engineering and Mining Journal.

243

DEWEY, F. B.—The Lewis and Bartlett Bag-Process of Collecting Lead-Fumes at the Lone Elm Works, Joplin, Missouri. By F. P. Dewey. Washington, D. C., 31 pp. <Vol. XVIII (Washington Meeting, February, 1890).

244

GAGE, J. R.—On the Occurrence of the Lead Ores in Missouri. By James R. Gage, M. E., St. Louis. 10 pp. <Vol. III, page 116.

245

MUNROE, H. S.—The New Dressing Works of the St. Joseph Lead Company, at Bonne Terre, Missouri. By H. S. Munroe, School of Mines, New York City. 20 pp. and 3 plates. <Vol. XVII, p. 659, Oct. 1888.

246

MUNROE.—The English versus the continental system of jigging—is close sizing advantageous? 23 pp. <Vol. XVII, page 637.

247

NEILL, J. W.—Notes on the Treatment of Nickel-Cobalt Mattes at Mine La Motte. By James W. Neill, E. M., Mine La Motte, Mo. 5 pp. <Vol. XIII, page 634, Feb. 1885.

248

NEWTON, H.—The Ores of Iron; their Geographical Distribution and Relation to the Great Centres of the World's Iron Industries. By Henry Newton, E. M., New York City. 32 pp. <Vol. III, page 360.
This has account of the Specular iron ores of Missouri.

249

NICHOLSON, F.—A Review of the Ste. Genevieve Copper Deposit. By Frank Nicholson, E. M., Ste. Genevieve. 13 pp. <Vol. X, page 444, 1882.

250

PACK, J. W.—Process of Spelter Production as Practiced at Carondelet, Missouri, with Comparisons. By John W. Pack, Rolla, Missouri. 6 pp. <Vol. III, page 125.

251

PRIME, F.—A Catalogue of Official Reports upon Geological Surveys of the United States and Territories, and of British North America. By Frederick Prime, Jr., Assistant Geologist of Pennsylvania. 71 pp. <Vol. VII, page 455. 1879.

252

PRIME.—Supplement I to a Catalogue of Official Reports, etc. 13 pp. <Vol. VIII, page 466. Feb. 1880.

253

RAYMOND, W.—Note on the Zinc Deposits of Southern Missouri. By Rossiter W. Raymond, Ph. D., New York City. 3 pp. <Vol. VIII, page 165. Sept., 1879.

254

WAIT, C. E.—Note on the New Chemical Laboratory of the Missouri School of Mines. By Professor Charles E. Wait, Rolla, Missouri. 5 pp., 3 Figs. <Vol. XV., page 21.

This was also issued as a pamphlet. Rolla, June, 1886, 14 pp., 16mo.

255

WILLIAMS, C. P.—Some Points in the Treatment of Lead Ores in Missouri. By Professor C. P. Williams, Ph. D., Rolla, Missouri. 16 pp. <Vol. V, page 314.

256

WILLIAMS, C. P.—Notes on the Method of Preparation of Zinc Oxide. By C. P. Williams. <Vol. V, pp. 422-426.

The ore noticed was from Hopewell, Washington County.

AMERICAN JOURNAL OF SCIENCE AND ARTS.

257

ADAMS, W. A.—Foot-marks and other Artificial Impressions on Rocks. By Prof. W. A. Adams, Zanesville, Ohio. 3 pp. <Vol. XLIV, page 200. 1843.

258

ANDREWS, E.—Dr. Koch and the Missouri Mastodon. By Edmund Andrews, M. D., Prof. of Surgery in the Chicago Medical College. 3 pp. <Vol. X, Third Series, page 32. 1875.

259

ANONYMOUS.—Calamine in Missouri. (Copied from New Harmony Gazette.) 3 pp. <Vol. XII, page 376.

260

ANONYMOUS.—Cobalt in Missouri. (Copied from New Harmony Gazette.) 1 page. <Vol. XII, page 378.

261

—Belcher's Artesian Well in St. Louis. (From the St. Louis Republican.) 3 pp. <Vol. XV, Second Series, page 460. 1853.

262

BARNARD, F. A. P.—Physics and Hydraulics of the Mississippi River. [By Prof. F. A. P. Barnard.] 9 pp. <Vol. XXXIII, Second Series, page 181. 1862.

263

BARNARD, F. A. P.—Physical Geography of the Report on the Mississippi River, by Humphrey and Abbot. [By Prof. F. A. P. Barnard.] 11 pp. <Vol. XXXV, Second Series, page 223. 1863.

264

BOURNE, A.—On the Prairies and Barrens of the West. By A. Bourne 5 pp. <Vol. II, page 30. 1820.

265

BRINGIER, L.—Notice of the Geology, Mineralogy, Topography, Productions, and Aboriginal inhabitants of the regions around the Mississippi and its confluent waters—in a letter from L. Bringier, Esq., of Louisiana, to Rev. Elias Cornelius—Communicated for this Journal. 32 pp. <Vol. III, page 15. 1821.

266

BROADHEAD, G. C.—Note on Pickeringite from Missouri. By G. C. Broadhead. 1 page. <Vol. VII, Third Series, page 520. 1874.

267

—On the Height of the St. Louis Directrix. 1 page. <Vol. X, Third Series, page 75. 1875.

268

—On a discovery of Meteoric Iron in Missouri. (From Mines, Metals and Arts, for Sept. 20, 1875.) 1 page. <Vol. X, Third Series, page 401. 1875.

269

BROADHEAD, G. C.—Drift formation and Gold in Missouri. (From Mines, Metals and Arts, St. Louis, Dec. 9, 1875.) 1 page. <Vol. XI, Third Series, page 150. 1876.

270

—On Barite Crystals from the Last Chance Mine, Morgan County, Missouri; and on Goethite from Adair County, Missouri. 2 pp. <Vol. XIII, Third Series, page 419. 1877.

271

—Origin of the Loess. 2 pp. <Vol. XVIII, Third Series, page 427 1879.

272

DANA, J. D.—On Dr. Koch's Evidence with regard to the Cotemporaneity of Man and the Mastodon in Missouri. By James D. Dana. (Article and note.) 12 pp. and 1 page. <Vol. IX, Third Series, pages 335 and 398. 1875.

This was reprinted in *Pop. Sci. Rev.* Vol. XIV, pp. 278-290.

273

DANA, E. S. and PENFIELD, S. L.—On Artificial Crystallized Lead Silicate; by Edward S. Dana and Samuel L. Penfield. 2 pp. <Vol. XXX, Third Series, page 138.

274

EDITORIAL.—Notice of "A View of the Lead Mines of Missouri, including some observations on the Mineralogy, Geology, &c., by Henry R. Schoolcraft." 14 pp. <Vol. III, page 59. 1821.

275

—The Mammoth (Mastodon ? Eds.) (Copied from Phil. Presbyterian of Jan. 12, 1839.) 3 pp. <Vol. XXXVI, page 198.

276

—Mastodon Giganteus. 3 pp. <Vol. II, Second Series, page 131. 1846.

This has a cut of the Koch Mastodon from Missouri, now in the British Museum.

277

EDITORIAL.—Gigantic Palæotherium. <Vol. —, page 288.

This notices the remains of a Palæotherium found “in the territory near St. Louis,” but instead of having been found near St. Louis, it was found in the Northwest on the Upper Missouri.

278

—“On the Coal Measures of Missouri: by G. C. Swallow.” 3 pp. <Vol. XXVI, Second Series, page 113.

279

—Notice of “Descriptions of New Species of Blastoidea from the Palæozoic rocks of the Western States, with some observations on the Structure of the Summit of the Genus Pentremites; by B. F. Shumard, M. D.” 1 page. <Vol. XXVI, Second Series, page 127.

280

—Notice of “Observations on the Geology of the County of Ste. Genevieve, being an extract from the Report made to the Missouri Geological Survey in 1859; by B. F. Shumard, M. D.” (Transactions St. Louis Acad. Sci.) 1 page. <Vol. XXIX, Second Series, page 126. 1860.

281

—Notice of “Third Series of Descriptions of Bryozoa, from the Palæozoic Rocks of the Western States and Territories; by H. A. Prout.” (Trans. St. L. Acad. Sci.) 2 pp. <Vol. XXIX, Second Series, page 126. 1860.

282

—Dr. Engelmann’s Measurement of the Elevation of St. Louis above the Gulf of Mexico. 3 pp. <Vol. XXX, Second Series, page 394. 1860.

283

—Notice of “Observations upon the rocks of the Mississippi Valley which have been referred to the Chemung Group of New York, together with descriptions of new species of fossils from the same horizon at Burlington, Iowa: by O. A. White and R. P. Whitfield.” 4 pp. <Vol. XXXIII, Second Series, page 422. 1862.

284

EDITORIAL.—Notice of "Geological Survey of Missouri: Raphael Pumpelly, Director. Preliminary Report on the Iron Ores and Coal Field from the field work of 1872." 2 pp. <Vol. VII, Third Series, page 61, 1874.

285

—Artesian Boring at the St. Louis Insane Asylum. 2 pp. <Vol. IX, Third Series, page 61. 1875.

286

—Notice of "Geological Sketch of the State of Missouri, illustrated by maps: by Geo. C. Swallow. 10 pp. large 4to. St. Louis. 1873. R. A. Campbell." 1 page. <Vol. IX, third Series, page 63. 1875.

287

—Notice of "Report of the Geological Survey of Missouri, including field work of 1873-4." 3 pp. <Vol. IX, Third Series, page 148. 1875.

288

—Forms and Origin of the Lead and Zinc deposits of Southwestern Missouri: by Adolf Schmidt. Abstracted from paper in Trans. St. Louis Acad. Sci. 2 pp. <Vol. X, Third Series, page 300. 1875.

289

—Remains of the Quaternary Peccary, *Platygonus Compressus*. 1 page. <Vol. XXXIX, page 322. 1890.

This gives Benton county as one of the localities where this fossil has been found.

290

ENGELMANN, G.—Remarks on the *Melonites multipora*. By G. Engelmann, M. D. 2 pp. <Vol. III, Second Series, page 124.

291

ENGELMANN.—Remarks on the St. Louis Limestone. 2 pp. <Vol. III, Second Series, page 119. 1847.

292

FLINT.—Earthquakes on the Mississippi; extracted from the travels of Mr. Flint. <Vol. XV, page 366.

293

HALL, J.—Note upon the Geology of the Western States. By James Hall, State Geologist of New York. 12 pp. <Vol. XLIII, page 51. 1842.

294

HALL.—Observations upon the Carboniferous Limestones of the Mississippi Valley. [Abstract.] 17 pp. <Vol. XXIII, Second Series, page 187. (From the proceedings of the American Association for the Advancement of Science.) See also Report of Progress of the Iowa Geological Survey.

295

HALL.—Remarks upon the Genus Archimedes or Fenistella from the Carboniferous Limestones of the Mississippi Valley. 2 pp. <Vol. XXIII, Second Series, page 203.

296

HARLAN, R.—Notice of two New Fossil Mammals from Brunswick Canal, Georgia; with observations on some of the fossil quadrupeds of the United States. By R. Harlan, M. D. 5 pp. <Vol. XLIII, page 141. 1842.

Notices the mastodon remains of the Koch collection, and gives his conclusion that the genus "*Tetracaulodon*," founded on them, was not good. His paper showing this had been published in his Medical and Physical Researches, page 257, and in Jameson's Edinburg Journal.

297

HARLAN, R.—Description of the Bones of a New Fossil Animal of the order Edentata. 12 pp. 3 plates. <Vol. XLIV, page 69. 1843.

This describes

Orycterotherium Missouriense, page 69, Pl. I, Figs. 1 to 18; Pl. II, Figs. 1 to 5; Pl. III, Figs. 1 to 9, from the Pomme de Terre, Benton county.

298

HARLAN, R.—Remarks on Mr. Owen's Letter to the Editors on Dr. Harlan's New Fossil Mammalia. 4 pp. <Vol. XLV, page 208. 1843.

299

HERRICK, E. C.—Fall of a Meteorite in Missouri, February 13, 1839. By E. C. Herrick. 2 pp. <Vol. XXXVII, page 385. 1839.

300

- HILGARD, E. W.—Remarks on the Drift of the Western and Southern States, and its Relation to the Glacier and Iceberg Theories. By Eug. W. Hilgard, Ph. D., State Geologist of Mississippi. 5 pp. <Vol. XLII, Second Series, page 343. 1866.

301

- HODGE, J. T.—On the Wisconsin and Missouri Lead Region. By James T. Hodge. 38 pp. <Vol. XLIII, page 35. 1842.

302

- HORNER, W. F.—Extracts from the Proceedings of the Am. Phil. Soc., containing an abstract of "Note of the Remains of the Mastodon, and some other extinct animals, collected together in St. Louis, Missouri; by W. E. Horner, M. D., Professor of Anatomy, University of Pennsylvania." 4 pp. <Vol. XL, page 56.

This is an account of the Koch collection.

303

- HUNT, T. S.—On some Reactions of the Salts of Lime and Magnesia, and on the Formation of Gypsums and Magnesian Rocks. By T. Sterry Hunt, F. R. S., of the Geological Survey of Canada. 19 pp. <Vol. XXVIII, Second Series, page 365, 1859.

This is part of an article continued from page 187 of the same volume. The part here given notices the magnesian limestones of Missouri.

304

- The Decay of Rocks Geologically considered. <Vol. XXVI, pp. 190-213.

The rocks of Missouri are considered on page 207.

305

- On some points in American Geology, 21 pp. <Vol. XXXI, Second Series, page 392.

306

- KEYES, C. R.—The Carboniferous Echinodermata of the Mississippi Basin. By Charles R. Keyes. 8 pp. <Vol. XXXVIII, Third Series, page 186.

307

KOCH, A.—Remains of the Mastodon in Missouri. [Communicated from A. Koch, proprietor of the St. Louis Museum, to the St. Louis Com. Bulletin, June 25, 1839. Copied in the Phil. Nor. Am., July 11, 1839.] 2 pp. <Vol. XXXVII, page 191. 1839.

308

KUNZ, G. F.—On some American Meteorites. By George F. Kunz. 11 pp. 1 plate. <Vol. XXXIV, Third Series, page 467.

A description with plate is given of the Taney County meteorite.

309

LECONTE, J. L.—Plumbo-resinite and Cupreous Sulphato-carbonate of Lead in Missouri. By J. L. LeConte, M. D. 1 page. <Vol. III. Second Series, page 117. 1847.

310

LOCKE.—The lead regions of the Upper Mississippi, with remarks on the geology of the west. By Prof. — Locke. 3 pp. <Vol. XLII, pages 147–149. 1842.

311

MEEK, F. B. AND WORTHEN, A. H.—Remarks on the Age of the Goniatite Limestone at Rockford, Indiana, and its relations to the "Black Slate" of the Western States, and to some of the succeeding rocks above the latter. By F. B. Meek and A. H. Worthen. 11 pp. and note. <Vol. XXXII, Second Series, pages 167 and 288. 1861.

312

NICOLLET, J. N.—On the Mineral region of the State of Missouri. By J. N. Nicollet. 2 pp. <Vol. XLV, page 340. 1843.

The above is in an abstract of the Proceedings of the Fourth Session of the Association of American Geologists and Naturalists.

313

NIPHER, F. E.—The Magnetic Survey of Missouri. By Francis E. Nipher. <Vol. XXI, pp. 310–312, 1881.

314

NORWOOD, J. G. & OWEN, D. D.—Description of a remarkable fossil Echinoderm, from the Limestone Formation of St. Louis, Missouri. By J. G. Norwood, M. D., and D. D. Owen, M. D. 4 pp. <Vol. II, Second Series, page 225, 1846.

This describes *Melonites multipora*, page 225, Figs. 1, 2, 3.

315

OWEN, R.—Letter from Richard Owen, Esq., F. R. S., F. G. S., &c., &c., on Dr. Harlan's Notice of New Fossil Mammalia. 5 pp. <Vol. XLIV, page 341. 1843.

316

OWEN, D. D.—Regarding Human Foot-Prints in Solid Limestone, with a plate. By David Dale Owen, M. D., of Indiana. 19 pp. 1 plate. <Vol. XLIII, page 14. 1842.

317

PARKER, J. D.—On the Fall of a Meteorite in Kansas City, Missouri, in June, 1878. By John D. Parker. 1 page. <Vol. XII, Third Series, page 316. 1876.

318

PUMPELLE, R.—The Relation of Secular Rock-disintegration to Loess, Glacial Drift and Rock Basins. By Raphael Pumpelly. 12 pp. <Vol. XVII, Third Series, page 133. 1879.

319

RICHARDSON, J.—Note on the Mastodon (?) and the Elephas primigenius. By Sir John Richardson. 2 pp. <Vol. XIX, Second Series, page 131. 1855.

320

SCHOOLCRAFT, H. R.—Remarks on the Prints of Human Feet, observed in the Secondary Limestone of the Mississippi Valley. By Henry R. Schoolcraft. 9 pp. 1 plate. <Vol. V, page 223.

321

SEAMON, W. H.—The Zinciferous Clays of Southwest Missouri and a theory as to the growth of the Calamine of that section. By W. H. Seamon. <Vol. XXXIX, pp. 38-42. 1890.

322

SHUMARD, B. F.—Supposed fall of Meteoric iron at St. Louis, Mo. By B. F. Shumard. 2 pp. <Vol. XXXIV, Second Series, page 443. 1862.

323

TROOST & LESUEUR.—Lead Ores in Missouri: by Messrs. Troost and Lesueur. (Copied from New Harmony Gazette.) 2 pp. <Vol. XII, page 379.

324

WHEELER, H. A.—Further Notes on the Artificial Lead Silicate from Bonne Terre, Mo. By H. A. Wheeler. 2 pp. <Vol. XXXII, Third Series, page 272.

325

WINCHELL, A.—On the identification of the Catskill Red Sandstone Group with the Chemung. By Prof. A. Winchell. 2 pp. <Vol. XXXV, Third Series, page 61.

The author of this paper holds to the equivalency of the Chemung, Marshall, Ohio, Rockford, Burlington and Chouteau strata, and that they are all Carboniferous.

AMERICAN MUSEUM OF NATURAL HISTORY BULLETIN.

326

WHITFIELD, R. P.—On the Fauna of the Lower Carboniferous Limestones of Spergen Hill, Indiana, with a revision of the descriptions of its Fossils hitherto published, and illustrations of the species from the original type series. By R. P. Whitfield. <Vol. I. No. 3, page 39.

The following species are given as found at Boonville, and are figured:

Pentremites conoides, Hall.

Orthis dubia, Hall.

Athyris trinucleus, Hall.

Terebratula turgida, Hall.

AMERICAN MINERALOGICAL JOURNAL.

327

MEADE, W.—Description and Analysis of an Ore of Lead from Louisiana [Missouri]. By W. Meade, M. D. 4 pp. <Vol. I. No. 1. Jan., 1810.

AMERICAN NATURALIST.

328

ANONYMOUS.—The Geological Survey of Missouri. By T. S. H. 6 pp. <Vol. IX, page 240. April, 1875.

329

BROADHEAD, G. C.—Fossil Horse in Missouri. By G. C. Broadhead. Read before the St. Louis Academy of Science, Nov. 15, 1869. 1 p. <Vol. IV, page 60.

330

—Quaternary Deposits. By G. C. Broadhead, St. Louis, Mo. 2 pp. <Vol. IV, page 61.

331

CALL, R. E.—The Loess of North America. By R. Ellsworth Call. 13 pp, 1 pl. and 8 pp. <Vol XVI, pages 369 and 542. 1882.

332

EDITORIAL.—Notice of "On the Antiquity of Man in North America," by Dr. J. W. Foster. 2 pp. <Vol. IV, page 40.

Gives an account of the statements of Dr. Koch in regard to finding flint implements with the mastodon remains in Missouri.

333

—Lead Mines in Missouri. 1 p. <Vol. IV, page 766.

Notice of a paper read by Mr. G. C. Broadhead before the St. Louis Academy of Science in October, 1870, on "Notes on the Geology of Cole County, Missouri."

334

EDITORIAL.—Note on Haworth's papers in the American Geologist on the Archæan Rocks of Missouri. 1 p. <Vol. XXII, page 732. 1888.

335

GORDON, C. H.—On the brecciated character of the St. Louis limestone. By C. H. Gordon. <Vol. XXIV, pp. 305–311. April, 1890.

This describes the character of the formation as found in Iowa, Illinois and Missouri.

336

HOY, P. R.—Dr. Koch's Missouri. By P. R. Hoy, M. D. 2 pp. <Vol. V, page 147.

337

NEWBERRY.—The Surface Geology of the Basin of the Great Lakes and the Valley of the Mississippi. (Copied from the Annals of the Lyceum of Natural History of New York, 1869.) 22 pp. <Vol. IV, page 193. 1870.

338

SPENCER, J. W.—Sand-Boulders in the Drift, or Subaqueous Origin of the Drift in Central Missouri. By Prof. J. W. Spencer. Read before the N. Y. meeting of A. A. A. S. 5 pp. 4 figs. <Vol. XXI, page 917. 1887.

339

SPENCER.—Hummocks and Boulders of Decomposition in Southeastern Missouri. 2 pp. <Vol. XXI, page 366. 1887.

340

SWALLOW, G. C.—Western coal measures and Indiana coal. By Prof. E. T. Cox. [With remarks by G. C. Swallow.] <Vol. 5, pp. 558–559.

Prof. Swallow states that he has been using Missouri coal which was fully equal to the "Block coal" of Indiana.

341

—Remarks on the geological map and section of the rocks of Missouri. By G. C. Swallow. <Vol. 5, pp. 541–542.

AMERICAN PHILOSOPHICAL SOCIETY PROCEEDINGS.

342

HARLAN.—Abstract of "Description of the Bones of a Fossil Animal of the Order Edentata, by Dr. Harlan." 3 pp. <Vol. II, page 109.

343

HAYS.—Remarks of Dr. Hays on a collection of fossil bones, chiefly of the Mastodon, brought to the city by Mr. Albert Koch, of St. Louis. 2 pp. <Vol II, page 102.

344

—Remarks of Dr. Hays on three papers recently read to the Geological Society of London, relative to the Mastodontoid animals in the collection of Mr. Koch. 3 pp. <Vol. II, page 264.

345

HORNER, W. E.—Abstract of "Note of the Remains of the Mastodon, and some other extinct animals collected together in St. Louis, Missouri; by W. E. Horner, M. D." 4 pp. <Vol. I, page 279.

346

—Abstract of "Remarks on the Dental System of the Mastodon, with an Account of some lower Jaws in Mr. Koch's collection, St. Louis, Missouri, etc., by Dr. Wm. E. Horner." 2 pp. <Vol I, page 306. 1840.

347

LESQUEREUX, L.—On the Cordaites and their related generic divisions, in the Carboniferous formation of the United States. By L. Lesquereux. 21 pp. <Vol. XVII, page 315. 1878.

The following species are described:

Cordaites communis, page 320, no fig.

C. diversifolius, page 320, Pl. XLVIII, Figs. 3, 3a. (Second Geological Survey of Pennsylvania, P. Vols. I, II and III, page 535; Plate LXXVII, Figs. 3, 3a.)

Lepidoxylon anomalum, page 334, Pl. LIV, Fig. 5; Pl. LV, Figs. 1. 1a, all from the Lower Coal Measures at Clinton.

The descriptions refer to plates and figures, but these were not published with the article.

348

- WHIPPLE, S. H.—Description of Mastodon bones found in Benton County, Missouri, and presented to the society. By S. H. Whipple. 2 pp. <Vol. IV, page 35.
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AMERICAN PHILOSOPHICAL SOCIETY TRANSACTIONS.

349

- HAYS.—Remarks of Dr. Hays on Abstract of Prof. Owen's paper on the Koch Collection to the London Geological Society. 2 pp. <Vol. II, page 183. 1842.
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350

- HARLAN, R.—Ichthyosaurian Remains discovered in the State of Missouri. By R. Harlan. 1831.

Also in Medical and Physical Researches, page 344. 1835. This title is a mistake. The specimens were from the Upper Missouri, and not the State of Missouri.

351

- HORNER, W. E.—Remarks on the Dental System of the Mastodon, with an account of some Lower Jaws in Mr. Koch's Collection, St. Louis, Missouri, where there is a solitary Tusk on the right side. By W. E. Horner, M. D., Professor of Anatomy in the University of Pennsylvania. 7 pp. <Vol. VIII, N. S., page 53.
-

352

- LEIDY, J.—Descriptions of the Remains of Fishes from the Carboniferous Limestones of Illinois and Missouri. By Joseph Leidy, M. D. 4 pp. 1 pl. <Vol. XI. N. S. Page 87. 1860.

This describes

Ctenoptychius digitatus, page 90, Pl. V, Fig. 27, from the Carboniferous Limestone near St. Louis.

BOSTON SOCIETY OF NATURAL HISTORY PROCEEDINGS.

353

- DESOR, E.—Remarks on a fine skeleton of a mastodon seen by him at Galena, Mo. By E. Desor. 1 page. <Vol. III, page 207. 1849.

354

HARRISON, E.—Analysis of Magnetite from Iron Mountain and Pilot Knob, Missouri. By Edwin Harrison. 1 page. <Vol. VI, page 295. 1857.

355

NEWBERRY, J. S.—Notes on the Surface Geology of the Basin of the Great Lakes. By Dr. J. S. Newberry. 5 pp. <Vol. IX, page 42.

356

SCUDDER, S. H.—Older Fossil Insects West of the Mississippi. By Samuel H. Scudder. 3 pp. <Vol. XXII, page 53. 1882-3.

This contains a notice of a hemipterous insect from Kansas City, the first discovered in rocks older than the Tertiaries.

357

WHITE, C. A.—Description of New Species of Fossils from the Devonian and Carboniferous Rocks of the Mississippi Valley. By Charles A. White, of Burlington, Iowa. 26 pp, 2 figs. <Vol. IX, page 8.

The following Missouri species are described:

Ambocælia (Spirifer ?) minuta, page 26, from Hannibal.

Streptorhynchus lens, page 28, and

Chonetes geniculata, page 29, from Clarksville, all from beds equivalent to the Chemung.

358

WHITE, C. A. & WHITFIELD, R. P.—Observations upon the Rocks of the Mississippi Valley which have been referred to the Chemung Group of New York, together with Descriptions of New Species of Fossils from the same Horizon at Burlington, Iowa. By C. A. White and R. P. Whitfield. 18 pp. <Vol. VIII, page 289.

CAMBRIDGE MUSEUM OF COMPARATIVE ZOOLOGY BULLETIN.

359

WHITNEY, J. D. & WADSWORTH, M. E.—The Azoic System and its proposed subdivisions. By J. D. Whitney and M. E. Wadsworth. <Vol. VII, No. XI. 1884.

The crystalline rocks of Missouri are noticed on page 482.

CHICAGO ACADEMY OF SCIENCE TRANSACTIONS.

360

MCCHESNEY, J. H.—Descriptions of New Species of Fossils from the Palæozoic Rocks of the Western States. By J. H. McChesney. Extr. Trans. Chicago Acad. Sci. <Vol. I. Chicago. 1859. 96 pp.

The title page indicates that this had previously been published in the Transactions of the Chicago Academy, but such was not the case, as will be seen by the next entry. The title page states the year of publication as 1859, but the author gives it in the subsequent paper as 1860.

The following species are described :

Orthis Richmondia, page — from 12 ms. nw. of Richmond.

O. Pratteni, page — from Charbonier.

Productus Wilberanus, page 36 (Trans. 1865, page 26, Pl. I, Fig. 8), from Charbonier.

Athyris differentis, page —, from Charbonier and Richmond.

Edmondia concentrica, page 55 (*Astartella concentrica*, Trans. 1865, page 43, Pl. II, Fig. 21), from Charbonier.

Myalina Swallowi, page 57 (Trans. 1865, page 41, Pl. II, Figs. 6a, b, from Charbonier and 12 ms. nw. of Richmond.

Discina capuliformis, page 72 (*D. capuliformis*, Trans. 1865, page 23, Pl. II, Fig. 20), from 12 ms. nw. of Richmond, all from the Coal Measures.

Actinocrinus tenuisculptus, page 15 (Trans. 1865, page 11, Pl. V, Fig. 1), from the Burlington at Columbia.

Athyris ultravarica, page —, from the Keokuk at Ste. Genevieve.

361

—Descriptions of Fossils from the Palæozoic Rocks of the Western States, with Illustrations. By J. H. McChesney, Professor of Geology and Mineralogy in the University of Chicago. 57 pp. 9 plates. <Vol. I, page 1. 1867-9.

See remarks under preceding number. Part of the species of that pamphlet are described again and figured as stated in the preceding number.

Hemipronites crassus, M. & H. is figured from the Coal Measures at Richmond, and *Edmondia concentrica* is changed to the genus *Astartella*.

CINCINNATI SOCIETY OF NATURAL HISTORY JOURNAL.

362

MILLER, S. A.—Descriptions of two new Species from the Niagara Group, and five from the Keokuk Group. By S. A. Miller, Esq., 6 pp. 1 pl. <Vol. II, page 254.

Describes the following species:

Platycrinus Bloomfieldensis, page 257.

Codaster graciosus, page 257.

Strotocrinus Bloomfieldensis, page 258, Pl. XV, Figs. 6, 6a, all from the cherty beds of the Keokuk at New Bloomfield.

363

—Descriptions of some new and remarkable crinoids and other fossils of the Hudson River Group, and notice of *Strotocrinus Bloomfieldensis*. 9 pp. 1 pl. <Vol. IV, page 69.

This has additional description and figure of *Strotocrinus Bloomfieldensis*, page 78, Pl. I, Fig. 6.

364

—*Glyptocrinus* redefined and restricted, *Gaurocrinus*, *Pycnocrinus* and *Compsocrinus* established, and two new species described. <Vol. VI, page 217.

This describes:

Gaurocrinus splendens, page 230, from the Trenton Group (?) at Cape Girardeau.

365

MILLER, S. A. and GURLEY, WM. F. E.—Description of some new genera and species of Echinodermata from the Coal Measures and Subcarboniferous Rocks of Indiana, Missouri and Iowa. By S. A. Miller and Wm. F. E. Gurley. 59 pp., 10 plates. <Vol. XIII, page 3. April, 1890.

The following Missouri species are described:

Eupachycrinus sphaeralis, page 5, Pl. I, Figs. 3, 4.

Ulocrinus Brittsi, page 7, Pl. I, Figs. 5, 6.

U. Kansasensis, page 8, Pl. I, Figs. 7, 8, 9, 10.

Delocrinus Missouriensis, page 14, Pl. II, Figs. 8, 12, 13.

Æsiocrinus magnificus, page 15, Pl. II, Figs. 1, 2, 3, 4, 5.

Æ. Harii, page 16, Pl. III, Fig. 1.

- *E. basiliscus*, page 53, Pl. IX, Figs. 4, 5, 6, all from the Upper Coal Measures at Kansas City.

Delocrinus hemisphericus, Shumard, from Kansas City, is figured on Pl. II, Figs. 8, 9, 10.

The following new descriptions are given :

Family *Eupachyrcrinidae*, page 3.

Genus *Ulocrinus*, page 6.

" *Delocrinus*, page 9.

" *Esiocrinus*, page 14.

The above abstract is of the entire paper as published in pamphlet form. The Journal at the date given contained only the first 25 pages and 4 plates.

366

ULRICH, E. O.—American Palæozoic Bryozoa. By E. O. Ulrich. <Vol. VII, page 24. 1884.

Rhombopora crassa, page 28, Pl. I, Figs. 2, 2a, 2b.

Fistulipora carbonaria, page 45, Pl. III, Figs. 1, 1a, both from the Upper Coal Measures at Kansas City.

DENISON UNIVERSITY, BULLETINS OF THE SCIENTIFIC LABORATORIES.

367

HERRICK, C. L.—A sketch of the Geological History of Licking County accompanying an Illustrated Catalogue of Carboniferous Fossils from Flint Ridge, Ohio. Appendix I. Carboniferous Trilobites. Appendix II. A Waverly Trilobite. By C. L. Herrick. <Vol. II, Part I, pp. 5-70.

Descriptions are given of several species of trilobites which were described from Missouri types, and the name *Proetus Missouriensis*, Shum., is changed to *Phillipsia Shumardi*, page 58, and page 69, Plate VII, Fig. 14.

GEOLOGICAL MAGAZINE.

368

EDITORIAL.—Review of Reports of the Geological Survey of the State of Missouri, 1855-1871, by Broadhead, &c. 2 pp. <Vol. I n. s. page 368. 1874.

369

—Review of the Mississippi Valley; its Physical Geography, &c., by J. W. Foster, Chicago, 1869. 3 pp. <Vol. VI, page 421. 1869.

GEOLOGICAL SOCIETY OF PENNSYLVANIA TRANSACTIONS

370

HARLAN, B.—Critical Notices of Various Organic Remains hitherto discovered in North America. By Richard Harlan, M. D. 47 pp. <Vol. I, Part 1, pages 46-112. 1834.

Contains description of *Bos Pallasii*, De Kay, from New Madrid.

371

TROOST, G.—On the organic remains which characterize the transition series of the valley of the Mississippi, &c. By G. Troost, M. D. In a letter to Dr. Harlan, of Philadelphia. 3 pp. <Vol. I, Part II, pages 248-250. 1835.

This gives a list of 49 species of fossils found in the "transition strata, including the mountain limestone of the English geologists." The author gives some other names in addition to the numbered list, and states that there are many other fossils, but that he had not yet determined them.

HUNT'S MERCHANTS' MAGAZINE.

372

DILLE, I.—Mineral Resources of Southern Missouri. Israel Dille of Ohio. 6 pp. <Vol. XIII, No. 3. April, 1845.

373

—Mineral Region and Resources of Missouri. 7 pp. <Vol. XV, No. 1, page 28. July, 1846.

374

FEUCHTWANGER, L.—Mineral Resources of Missouri. Mineralogical Observations in the State of Missouri, made by Dr. Lewis Feuchtwanger. Read before the New York Lyceum of Natural History. 5 pp. <Vol. XVI. No. 2, page 177. Feb., 1857.

375

LAMBORN, R. H.—Missouri Iron Region. By Robert H. Lamborn, Esq., of St. Louis. 7 pp. <Vol. 53, page 329. Nov., 1865.

376

WHITTELSEY, C. C.—Missouri and its Resources. [C. C. Whittelsey, of Missouri.] 10 pp. <Vol. VIII, page 535. June, 1843.

KANSAS ACADEMY OF SCIENCE TRANSACTIONS.

377

HAWORTH, E.—The Coal Fields of Cherokee County, Kansas. By Erasmus Haworth, B. S., Empire City, Kansas. 5 pp. <Vol. VIII, page 7, 1881-2.

This has notes on the geology of the adjoining parts of Missouri.

KANSAS CITY REVIEW OF SCIENCE AND INDUSTRY.

378

ANONYMOUS.—The Mineral Resources of Missouri. <Vol. I, pp. 144-147.

379

— Analysis of Sweet Springs Water, Saline County, Mo. <Vol. I, page 186.

380

— A Fourth Oil Rock. <Vol. I, page 491.

Notices an oil-bearing sand at 1645 feet, at Big Shanty, south of Bradford, Missouri.

381

— Missouri Mineral Production. From the Engineering and Mining Journal. 3 pp. <Vol. II, No. 2, pp. 104-106. May, 1878.

382

— Ancient Man in Missouri. (From the Scientific American.) 2 pp. <Vol. IV, No. 6, pp. —. Oct., 1880.

383

- BALLARD, F. A.—Mastodon Remains found in Jackson County, Mo.
By Dr. F. A. Ballard, Independence, Mo. 2 pp., 1 Ill. <Vol. III,
No. 11, page 643. March, 1880.

384

- BAUCHER, W.—[Stump of Oak five feet deep in prairie soil, Oregon
Mo. By W. Baucher.] <Vol. I, page 509.

385

- BROADHEAD, G. C.—Thickness of the Missouri Coal Measures. By
Prof. G. C. Broadhead. 2 pp. <Vol. I, No. 7, pages 392–393.
Sept., 1877.

386

- Missouri Iron Ores of Carboniferous Age. <Vol. I, page 650.

387

- Mineralogy. Bitumen, Asphaltum, Petroleum, Pyroschists, and
certain other solid Hydro-carbons. (Read before the Kansas City
Academy of Science, November 28, 1876.) <Vol. I, No. 4, pages
209–224. June, 1877.

This contains an account of oil and bitumen in Western Missouri.

388

- Meteoric Stones and Shooting Stars. 19 pp. <Vol. I, No. 12,
pages —. Feb., 1878.

This notices the different Missouri meteorites.

389

- Jackson County, Missouri—A few notes on its Geology. 7 pp.
<Vol. II, No. 4, pages 204–210. July, 1878.

390

- Notes on Surface Geology of Southwest Missouri and Southeast
Kansas. 2 pp. <Vol. III, No. 8, pp. 460–461. Dec., 1879.

391

- Review of Contributions to Palæontology. Nos. 2–8. By C. A.
White, M. D. 2 pp. <Vol. IV, No. 7, pp. 448–449. Nov., 1880.

Several of the Missouri fossils described by Dr. White in these Contribu-
tions were sent to him by Prof. Broadhead, who here adds some facts in regard
to them and their geology.

392

BROADHEAD, G. C.—The Mastodon. <Vol. IV, No. 9, pp. 519-530. Jan., 1881.

An account is given of the Mastodons found near Sedalia by Mr. R. A. Blair.

393

— The Marbles of Southeast Missouri. 4 pp. <Vol. V, No. 9, page 523. Jan., 1882.

394

— Archæan Rocks of Missouri. <Vol. V, No. 12, page 733. 1882

395

BROADHEAD.—Old maps. 3 pp. <Vol. VII, No. 1, pp. 56-58. May, 1883.

This gives an account of the old geological and other maps of the State.

396

— Flint Chips. 3 pp. <Vol. VII, pp. 599-602.

An account is given of the different chert-beds of Missouri.

397

— Explorers of Western America. 6 pp. <Vol. VII, No. 7, pp. 407-412. Nov., 1883.

The reports of the different explorers who traveled in Missouri are noticed.

398

— Mines of Carterville, Jasper Co., Missouri. 3 pp. <Vol. VIII, Nos. 2-3, pp. 70-72. June-July, 1884.

399

CASE, T. S.—The Mineral Region of Southwest Missouri and Southeast Kansas. By the Editor. [Theo. S. Case.] 7 pp., 2 wood cuts. <Vol. I, No. 7, page 385. Sept., 1877.

400

CASE.—Missouri Copper Mines. [Editorial.] 3 pp. <Vol. VI., No. 5, page 304. Sept., 1882.

401

CASE.—Geological Surveys of Kansas and Missouri. 4 pp. <Vol. VI, Nos. 9-10, pp. 592-5. 1880.

402

CASE.—Notice of "Geology and Mineralogy of Cherokee County, Kansas, by Erasmus Haworth, B. S." 1 p. <Vol. VIII, Nos. 2-3, page 146. June-July, 1884.

403

CLERC, F. A.—The Lead and Zinc Region of Missouri and Kansas. F. A. Clerc. (From the Mineral Resources of the U. S.) 6 pp. <Vol. VII, No. 6, page 330. Oct., 1883.

404

EMERY, J. B.—Description of Marble Cave, Missouri. (Stone County.) Capt. J. B. Emery, 9 pp. <Vol. VIII, No. 11, page 614. March, 1885.

405

GAGE, J. R.—The Ste. Genevieve County Copper Mines. By J. R. Gage. <Vol. I, pp. 603-605.

406

HAWORTH, E.—The Chert Rocks of Sub-carboniferous Kansas. By Erasmus Haworth, B. S. <Vol. V, No. 11, pp. 669-676. March, 1882.

This describes the formation in which the lead and zinc of Southwest Missouri are found.

407

LEWIS, J. L.—Fossil Remains in Southwest Missouri. J. L. Lewis, Bolivar, Missouri. 1 page. <Vol. IV, No. 4, page 207. Aug., 1880.

408

LYKINS, W. H. R.—Kansas City Fossils. W. H. R. L[ykins.] 1 page. <Vol. VII, No. 2, page 113. June, 1883.

409

LYKINS, W. H. R.—List of Fossils in Kansas City and Vicinity. 5 pp. <Vol. VIII, Nos. 2-3, page 72. June-July, 1884.

410

PHILLIPS, J. V. C.—Geology of the West. By J. V. C. Phillips. <Vol. I, pp. 488-491.

Describes the section of the St. Louis Insane Asylum well.

411

SPENCER, J. W.—The Ancient Mississippi and its Tributaries. J. W. Spencer, Professor of Geology in the State University of Missouri. 7 pp. <Vol. VI, No. 11, pp. —.

412

TROWBRIDGE, S. A.—Geological Survey of Missouri. Prof. S. H. Trowbridge. 6 pp. <Vol. VI, No. 11, page —.

413

WEST, E. P.—Human Remains in the Loess of the Missouri River. E. P. West. 4 pp. <Vol. VI, No. 8, page —. Dec., 1882.

414

— Age of the Missouri River. 4 pp. <Vol. VII, No. 1, page 25-28. May, 1883.

LYCEUM OF NATURAL HISTORY OF NEW YORK ANNALS.

415

DEKAY, J. E.—Notes on a fossil skull in the Cabinet of the Lyceum, of the Genus *Bos*, from the banks of the Mississippi; with observations on the American species of that Genus. By J. E. DeKay. 12 pp. <Vol. II, page 280.

Describes the following:

Bos Pallassii, page 280, Pl. C, from New Madrid.

416

NEWBERRY, J. S.—On the Surface Geology of the Basin of the Great Lakes, and the Valley of the Mississippi. By J. S. Newberry. 22 pp. <Vol. IX, page 213.

THE MINING MAGAZINE OF WM. J. TENNEY, New York.

“MINING AND STATISTICAL MAGAZINE,” Thomas McGrath; and “MINING MAGAZINE AND JOURNAL OF GEOLOGY,” T. P. Blake.

The two latter magazines were successors to the first.

417

ANONYMOUS.—Manufacture of Iron at St. Louis. (Communication to St. Louis Republican.) <Feb. 1860, pp. 312-313.

The cost of production of iron at Iron Mountain and Pilot Knob is given.

418

BAILEY.—Iron Manufacture in Missouri. (Copied from Western Journal.) <Vol. II, No. 5, May, 1854. pp. 581–583.

419

EDITORIAL.—Missouri Coal. 2 pp. <Vol. III, No. II, Aug., 1854, page 216.

420

— Lead Mining in Missouri. 2 pp. <Vol. III, No. IV, Oct., 1854, page 440.

421

— Geological Survey of Missouri. <Dec., 1859, p. 159.
Notice of and quotation from Swallow's Fourth Report.

422

— Reported Discovery of Gold Mines in Missouri. <Vol. I, Second Series, pp. 406–407. March, 1860.

Notice of mines then reported found in Madison County, which, according to Koch, produced ore worth over \$100,000 per ton.

423

JAMISON, J.—Coal Fields and Coal Mines on the Western Waters. J. Jamison in Report of Chief of Bureau of Construction to the Secretary of the Navy. <Vol. I, No. 6, page 654. Dec., 1853.

424

ST. LOUIS REPUBLICAN.—Missouri Lead Mines. By Editor of St. Louis Republican. 2 pp. <Vol. I. No. V, page 525. Nov., 1853.

425

— Iron Mountain and Pilot Knob, Missouri. (Copied from St. Louis Republican.) 2 pp. <Vol. II. No. IV, page 453. April, 1854.

426

WESTERN JOURNAL.—Iron and Zinc. Iron Mountain Region, Mo. 3 pp. (Copied from Western Journal.) <Vol. V. No. 1, July, 1855.

427

WHITNEY, J. D.—The Lead Deposits of the Mississippi Valley. By J. D. Whitney. <Dec. 1859, pp. 89–102; Jan. 1860, pp. 169–184; Feb. 1860, pp. 287–299.

Extracted from the Geological Survey of Iowa, Vol. I. A few references to Missouri, but mostly Iowa and other northern places.

MINES, METALS AND ARTS, OF ST. LOUIS, J. E. WARE, EDITOR.

428

The following list of articles from the above publication has been furnished by Prof. Broadhead: (*)

1874.

May 7—Simpson's Coal and Lead Mines. Editorial.

May 14—How is the interest in Missouri Iron property to be restored? Editorial.

do. P. H. Schneider's Granite Quarries.

May 28—School of Mines.—Granby Mines. Editorial.

do. Missouri Minerals. Simpson Mines, etc. Editorial.

July 2—Fire Clay. "By Musquito."—D. A. Bauman.

July 9—Developing Lead and Zinc. "Musquito."

do. Fire Brick. Edit.

July 23—Mines and furnaces S. E. Mo.—Mo. Lead for 1874.—Missouri ores.

Edit.—Joplin and its Mines. Speech by J. V. Wheelhouse.

July 30—Missouri Mines.

Aug. 13—St. Jo Mines. Edit.

Aug. 20—Several items Missouri mines. Edit.

Missouri Zinc, D. Bauman. Chouteau League Tract Mines, do.

Aug. 27—Dade county Zinc. Edit.

Sept. 3—Old Mines Conception. D. Bauman.

Sept. 10—Higginbotham Lead Mines. D. Bauman.

Sept. 17—S. W. Mo. Lead and Zinc.—St. Joe & Valle Mines. Edit.

Sept. 24—Shibboleth Mines.—Washington Co. coal. D. Bauman.

Lincoln county coal Edit.

Oct. 8—Sandstone quarries—Zinc—Lead—Fire brick. Edit.

Oct. 15—Palmer Lead Mines. D. Bauman.

Oct. 22—Lead Mining Jasper Co.—Joplin Mines. Edit.

Nov. 5—S. E. Mo. Lead Mines. D. Bauman.

Nov. 5, 12, 19, 26, Dec. 3, 10, 24, 31—State Geological Reports. Edit.

Dec. 12—S. W. and S. E. Mo. Mines.

Dec. 19—Missouri Mines. Edit.

Dec. 26—Dade county Mines. D. Bauman.

do. Missouri Ores and Mines. Edit.

- Dec. 3—Missouri Mines.
 Dec. 10—Missouri Mining Interests.—Mo. Geol. Survey. Edit.
 Dec. 17—Jasper county Mining Items. Edit.
 Dec. 24—S. E. and S. W. Mo. Mines.
 do. Iron and Copper in Missouri. R. S. Elliott.

1875.

- Jan. 7, 21, Feb. 11—Geological Survey and Reports. Edit.
 Jan. 14—Dade county Mines.
 Jan. 21—Central Missouri Lead Mines—Linn Creek Mines.
 do. Mining Regions, S. W. Mo. W. S. Guy.
 Feb. 18—Joplin, etc., Lead Statistics. Edit.
 Feb. 25—Lead in Christian county.
 March 25—Missouri Mining Items.
 April 1—S. W. Mines and Furnaces—Iron Ores. Edit.
 April 8—Iron interests and Lead. Edit.
 April 27—Pettis and Pulaski counties mines. Correspondence. Mines and
 furnaces in Missouri. Edit.
 May 6—Johnson county Iron Ore.
 May 27—Mine La Motte. Mining Industries in Missouri.
 June 3—Mines S. E. Mo. Edit.
 June 24—Missouri Mines.
 July 15—Iron Ores of Missouri. J. L. Bell.
 Aug. 19—Mines S. W. and S. E. Mo. Edit.
 Sept. 9—Washington county Mines, Webbville.
 Sept. 16—Mo. Lead Mines—Discoveries of Lead in Missouri and Mine La
 Motte.—Washington Co. Mines.—Cartersville Mines.
 Sept. 23—Ste. Genevieve Copper Mines.—Missouri Lead Mines.
 Oct. 7—Missouri Gold. J. T. Reiston.
 Oct. 21—S. W. Mo. mines.
 Nov. 4—Granby Mines.
 Nov. 25—Missouri Gold. C. F. Williams and Edit.
 Dec. 16—Desloge Mines, Southeast Missouri.

1876.

- Jan. 6—Iron Mountain and Irondale furnaces. Missouri Gold Field.
 March 2—Zinc production in Missouri. Lead in S. W. Missouri. Annual
 production of lead in Mo. E. A. Casswell and Ed.
 April 13—Lead in Missouri. Ed. Dunscomb.
 June 1—S. W. Mo. Mines.
 June 22—Desloge Mines.
 June 29—Dade county mines.
 Aug. 10—Missouri Mines. Cantwell.
 Sept. 7—Joplin and Granby.
 Oct. 19—S. E. Mo. mines.

1877.

- Jan. 25—Lead discoveries at Granby. Production of lead.
 June 14—S. E. Mo. Mines.
 July 12—Missouri mines.
 Oct. 15—Missouri mines.
 Nov. 11—Ste. Genevieve Mines. J. R. Gage.
 Dec. 20—Lead interest in Missouri.

1878.

Jan. 10—Production of mines.

Also the following papers by Prof. Broadhead:

Physical Geography Mississippi Valley. Feb., 1876.

Iron Ores Carboniferous Age. Feb. 25, 1876.

Geological Notes S. E. Mo. Reynolds Co. March, 1876.

Area and Topographic features S. W. coal field. 1874.

Morgan Co. Lead Mines. Sept. 2, 1875.

Meteoric Iron in Mo. Sept. 19, 1875.

Meteoric Iron, referring to Dr. Shumard's notes. Oct. 14, 1875.

St. Joe Mines, S. E. Mo. Oct. 21, 1875.

Visit to S. E. Mo. Mines. Oct. 28, 1875.

Drift formation and Gold in Mo. Dec. 9, 1875.

Mines of Morgan and Benton Co. July 29, 1875.

Mines of Cole Co., Mo. Aug. 12, 1875.

Coal S. W. Mo. Dec. 20, 1877.

Bituminous shales. Feb. 15, 1877.

NEW YORK ACADEMY OF SCIENCE—ANNALS.

429

Vogdes, A. W.—The Genera and Species of North American Carboniferous Trilobites. By Anthony W. Vogdes. <Vol. IV, pp. 69-105. Feb., 1888.

The Carboniferous formations of Missouri are noticed. Descriptions and notices of the following species from the State are given:

Proetus Missouriensis, Shumard, page 75, Pl. III, Fig. 1, from the Lithographic Limestone (Waverly series) at Hannibal, Louisiana and Chouteau Springs.

Phillipsia major, Shumard, page 85, Plate III, Fig. 14, from the Upper Coal Measures, Clinton County and Kansas City.

P. Missouriensis, Shumard, page 86, Pl. III, Figs. 1-2, from the Middle Coal Measures, Lexington.

P. Merameccensis, Shumard, page 86, Pl. III, Fig. 15, from the Archimedes limestone [Chester series], Fenton, St. Louis county.

NEW YORK ACADEMY OF SCIENCE TRANSACTIONS.

430

SAMPSON, F. A.—Notes on the Subcarboniferous Series at Sedalia, Missouri. By F. A. Sampson. 2 pp. <Vol. VII, page 246. 1888.

43¹

VOGDEN, A. W.—Description of two new Species of Carboniferous Trilobites. By A. W. Vogdes. 4 pp. <Vol. VII, page 247. 1888

This describes the following species:

Phillipsia Sampsoni, page 24, figure, from the Waverly Series (Chouteau Limestone).

Griffithides (?) *Sedaliensis*, page 24, from the Waverly Series (Chouteau Limestone), both at Sedalia.

NORTH AMERICAN REVIEW.

43²

EDITORIAL.—Missouri. Review of "Gazetteer of the State of Missouri, by Alphonso Wetmore, St. Louis, 8vo., 1837." 13 pp. <No. CIII, page 514. April, 1839.

433

— The Missouri Valley and the Great Plains. 29 pp. No. CLXXX, page 66. July, 1858.

PHILADELPHIA ACADEMY NATURAL SCIENCE JOURNAL

434

LEIDY, J.—Descriptions of some remains of Fishes from the Carboniferous and Devonian Formations of the United States. B. Joseph Leidy, M. D. 7 pp. 3 plates. <Vol. III, Second Series page 159. 1854.

The following Missouri species is described:

Oracanthus vetustus, page 1. Plate — from Missouri Territory, exact place not known.

435

NORWOOD, J. C., & PRATTEN, H.—Notice of Producti found in the Western States and Territories, with descriptions of twelve new species. By J. C. Norwood and Henry Pratten of the Illinois Geological Survey. 18 pp. 2 plates. <Vol. III, Second series, page 5. Aug. 1854.

The following are described :

- Productus Rogersii*, page 9, Pl. I, Fig. 3, a, b, c, Huntsville.
P. splendens, page 11, Pl. I, Fig. 5, a, b, c, d, 6 miles west of Richmond.
P. muricatus, page 14, Pl. I, Fig. 8, a, b, c, d, e, 6 ms. nw. of Richmond.
P. Portlockianus, page 15, Pl. I, Fig. 9, a, b, c, Charboniere.
P. Prattenianus, page 17, Pl. I, Fig. 10, a, b, c, d, 85 ms. nw. of St. Joseph.
P. Hildrethianus, page 18, Pl. I, Fig. 11, a, b, c, Charboniere, all from the Coal Measures.
P. elegans, page 13, Pl. I, Fig 7, a, b, c, from the Mountain Limestone near Hat Island.
Missouri localities of various other species are also given.

436

— Notice of the genus Chonetes, as found in the Western States and Territories, with descriptions of eleven new species. 8 pp. 1 plate. <Vol. III, page 23, Second series. 1854.

Describes the following species :

- Chonetes Flemingii*, page 26, Pl. II, Fig. 5, a, b, c, d, e, from 10 ms. nw. of Richmond.
C. Verneuilliana, page 26, Pl. II, Fig. 6 a, b, c, and
C. mesoloba, page 27, Pl. II, Fig. 7, a, b, c, from the Coal Measures at Charboniere.
Missouri localities are also given of other species.

437

— Notice of Fossils from the Carboniferous Series of the Western States, belonging to the genera Spirifer, Bellerophon, Pleurotomaria, Macrocheilus, Natica and Loxonema, with descriptions of eight new characteristic species. 7 pp. 1 plate. <Vol. III, page 71, Second series. 1854.

This describes :

- Spirifer spinosus*, page 71, Pl. IX, Fig, 1, a, b, c, d, from the Mountain Limestone of Missouri opposite Hat Island.

438

NUTTALL, T.—Observations on the Geological Structure of the Valley of the Mississippi. By Thomas Nuttall, read December, 1820. <Vol. II, Part I, pp. 14–52, 1821.

PHILADELPHIA ACADEMY NATURAL SCIENCE PROCEED-
INGS.

439

FRAZER, P.—[Remarks on Pilot Knob, Iron Mountain and Mine La Motte Districts.] By Prof. Persifor Frazer, Jr. 2 pp. <1874, Part II, page 85.

440

GODDARD, P. B.—Remarks on *Missourium Kochii*. By Dr. Paul B. Goddard. 2 pp. <Vol. I, page 115. 1841.

441

KOENIG, G. A.—Mineralogical Notes. By Dr. G. A. Koenig. <1876, page 156.

Gives analysis of earthy barite from St. Louis.

442

LEEDS.—Remarks concerning a great elevation of temperature in an adit level of a lead mine in Missouri, by Prof. Leeds. 2 pp. <1874, Part II, page 145.

443

MEEK, F. B. & WORTHEN, A. H.—Descriptions of New Palæozoic Fossils from Illinois and Iowa. By F. B. Meek and A. H. Worthen. 21 pp. <1861, page 128.

Describes from Missouri:

Productus magnus, page 142, no fig. (Illinois Survey, Vol. III, page 528, Pl. 30, Figs. 7a, b, c), Keokuk Limestone, Ste. Genevieve county.

444

— Descriptions of New Species of Orinoidea, &c, from the Palæozoic rocks of Illinois and some of the adjoining States. 13 pp. <1865, No. 3, page 143.

Describes the following:

Comarocystites Shumardi, page 143, no fig. (Illinois Survey, Vol. III, page 292, Pl. I, Fig. 1a, b).

C. Shumardi var *obconicus*, page 144, no fig. (Illinois Survey, Vol. III, page 294, Pl. I, Figs. 2a, b), both from the Trenton Limestone at Cape Girardeau.

445

MEEK, F. B. and WORTHEN, A. H.—Descriptions of New Crinoidea, &c., from the Carboniferous Rocks of Illinois and some of the adjoining States. By F. B. Meek and A. H. Worthen. 12 pp. <1865. No. 3, page 155.

Describes the following:

Evactinopora radiata, page 165 (Illinois Survey, Vol. III, page 502, Fig. also Pl. 17, Figs. 2a, b), from the Subcarboniferous of Missouri.

446

— Contributions to the Palæontology of Illinois and other Western States. 29 pp. <1865. No. 5, page 245.

Describes the following:

Nautilus (Cryptoceras) capax, page 262, from the Coal Measures at Charboniere.

447

— Contributions to the Palæontology of Illinois and other Western States. 25 pp. <1866. Page 251.

Describes the following:

Macrodon micronema, page 261.

Platyceras lævigatum, page 263.

Naticopsis Littonana, var *Genevievensis*, page 268.

Trochita (?) carbonaria, page 270, all from the Chester in Ste Genevieve Co.

Missouri localities are also given of other species.

448

MEEK.—Observations on the Microscopic Shell Structure of *Spirifer cuspidatus*, Sowerby, and some similar American forms. 3 pp. <1865, No. 5, page 275.

Various forms from Missouri are considered.

449

MEEK, F. B.—Descriptions of New Species of Fossils from Ohio and Western States and Territories, by F. B. Meek. <1871, page 159.

Describes the following:

Aviculopecten ? Williamsi, page 178, from Chouteau Limestone at Chouteau Springs.

450

— Notice of a New Brachiopod from the Lead-bearing Rocks at Mine La Motte, Missouri. 3 pp. <1871, page 185.

Describes:

Lingulella Lamborni, page 185, Figs. 1-4.

451

OWEN, D. D.—Remarks on Stone Slabs containing supposed imprints of human feet, by Dr. D. D. Owen. 1 page. <Vol. VI, page 106. 1852.

452

ROMINGER, C.—Observations on Chætetes and some related Genera, in regard to their systematic Position; with an appended description of some New Species. By Dr. Carl Rominger. 11 pp. <1866. page 113.

Describes the following :

Callopora Missouriensis, page 117, locality and position not given.

Fistulipora trifolia, page 122.

F. compressa, page 123.

F. peculiaris, page 123, all from the Keokuk Limestone at LaGrange.

453

WINCHELL, A.—Descriptions of New Species of Fossils, from the Marshall Group of Michigan, and its supposed equivalent, in other States; with Notes on some Fossils of the same age previously described. By Professor Alexander Winchell. 25 pp. <1865. No. 3, page 109.

Describes the following :

Conopoterium effusum, page 111.

Zaphrentis Ida, page 111.

Spiriferina Clarksvillensis, page 119, all from Clarksville.

Spirigera Missouriensis, page 117, from Louisiana, all from the Lithographic Limestone.

Missouri localities are also given of various other species.

ST. LOUIS ACADEMY OF SCIENCE TRANSACTIONS.

454

BROADHEAD, G. C.—Fossil Horse in Missouri. By G. C. Broadhead, 2 pp. <Vol III, page xx, Oct. 4, 1869.

455

— Bones of Large Mammals in Drift. 2 pp. <Vol. III, page xxii, Nov. 15, 1869.

Accounts of fossil remains from various parts of Missouri are given.

456

- BROADHEAD, G. C.—Mineralogy of Cole County, Missouri. 2 pp.
<Vol. III, page xxxiii, Nov. 21, 1870.

457

- Coal Measures in Missouri. By G. C. Broadhead. 23 pp. <Vol. II, page 311.

458

- Missouri Geological Surveys. Historical Memoir. By G. C. Broadhead. 14 pp. <Vol. IV, page 611.

459

- Occurrence of Bitumen in Missouri. By G. C. Broadhead. 3 pp.
<Vol. III, page 224.

460

- On the Well at the Insane Asylum, St. Louis County. By G. C., Broadhead. 8 pp. 1 pl. <Vol. III, page 216.

461

- Age of our Porphyries. By G. C. Broadhead. 5 pp. <Vol. III, page 366. Also supplemental note in Vol. III, page ccxix, June 19, 1876. 1 page.

462

- Carboniferous Rocks of Eastern Kansas. By G. C., Broadhead 12 pp. <Vol. —, page 481.

This shows the correspondence between the formations of eastern Kansas and western Missouri.

463

- ENGELMANN, G.—Elevation of St. Louis above the Gulf of Mexico. By George Engelman, M. D. 5 pp. <Vol. I, page 663.

464

- The Variations of the Stage of the Mississippi River at St. Louis. By George Engelmann, M. D. <Vol. II, page 420.

465

- GAGE, J. R.—On the Occurrence of Iron Ores in Missouri. By Jas. R. Gage, M. E., Assistant State Geologist of Missouri. 12 pp. <Vol. III, page 181.

466

HAMBACH, G.—Description of new Palæozoic Echinodermata. By G. Hambach. 7 pp. 2 plates. <Vol. IV, page 548 1884.

Describes the following Missouri species :

Melonites crassus, page 548, Pl. C., Fig. 1.

M. irregularis, page 549, Pl. C., Fig. 2.

Oligoporus parvus, page 550, Pl. C., Fig. 3.

Archæocidarus Newberryi, page 551, Pl. D., Fig. 1, all from the St. Louis Limestone at St. Louis.

Pentremites Sampsoni, page 551, Pl. D., Fig. 2, 2a, from the Chouteau Limestone of Pettis County.

Odonites campanulatus, page 553, Pl. D., Figs. 8, 9, from the Burlington Limestone at Sedalia.

467

HARRISON, E.—Age of the Porphyry Hills of Southeast Missouri. By Edwin Harrison, B. S. 1 page, 1 fig. <Vol. II, page 504.

468

HOLMES.—Remarks by Mr. Holmes upon the Loess and Drift in connection with the Big Mound at St. Louis. 5 pp. <Vol. II, page 565.

469

— Remarks on Col. Forshey's "Delta of the Mississippi." 2 pp. <Vol. III, page cxiv.

470

HOLMES.—Man and the Elephant in Nebraska. Remarks by Judge Holmes. 2 pp. <Vol. III, page ccxiii. May 15, 1876.

Refers to the accounts by Dr. Koch of man and the mastodon in Benton and Gasconade counties.

471

KOCH, A. C.—Mastodon Remains in the State of Missouri, together with Evidences of the existence of Man contemporaneously [sic] with the Mastodon. By Dr. Albert C. Koch. 4 pp. <Vol. I, page 61.

472

LEONHARD, A. V.—On the Occurrence of Millerite in St. Louis. By A. V. Leonhard. 3 pp., 2 plates. <Vol. IV, page 493.

473

— Notes on the Mineralogy of Missouri. 13 pp. <Vol. IV, page 440.

474

- LITTON, A.—Belcher & Brother's Artesian Well. By A. Litton, M. D.
7 pp., 1 plate. <Vol. I, page 80.

475

- MCGEE, W. J.—Notes on the Geology of Macon County, Missouri.
By W. J. McGee, U. S. Geologist. 32 pp., 2 maps, 4 figs. <Vol.
V, page 305.

476

- PROUT, H. A.—First of a Series of Descriptions of Carboniferous
Bryozoa. By H. A. Prout, M. D. 3 pp., plates. <Vol. I, page
235. 1858.

Describes from Missouri:

Fenestrella St. Ludovici, page 235, Pl. 15, Figs 1, 1a, from the Upper layers of the
St. Louis Limestone at St. Louis.

477

- Third Series of Descriptions of Bryozoa from the Palæozoic Rocks
of the Western States and Territories. 10 pp., 4 plates. <Vol. I,
page 443. 1859.

Describes the following:

Fenestrella hemitrypa, page 444, Pl. 17, Figs. 3, 3a, b, c, d.

Flustra spatulata, page 446, Pl. 17, Figs. 2, 2a, 2b, 2c.

F. tuberculata, page 447, Pl. 17, Figs. 3, 3a, b, c, d.

Fenestrella Banyana, page 450, Pl. 18, Figs. 4, 4a, 4b. All from the Second
Archimedes Limestone at Barrett Station, St. Louis County.

478

- Fourth Series of Descriptions of Bryozoa from the Palæozoic
Rocks of the Western States and Territories. 11 pp. <Vol. I,
page 571. 1860.

Describes the following:

Coscinium plumosum, page 572 (Illinois Survey, Vol. II, page 414, Pl. 22, Figs.
3, 3a, from the St. Louis Group, Barrett's Station), from the Second Archi-
medes Limestone at Barrett's Station.

Cyclopora fungia, page 577, (Illinois Survey, Vol. II, page 419, Pl. 22, Figs. 9,
9a, 9b), from the Keokuk Limestone at St. Francisville.

479

- Description of a new Species of *Productus*, from the Carbonifer-
ous Limestone of St. Louis. 3 pp., 1 pl. <Vol I, page 43. 1857.

Describes the following:

Productus marginicinctus, page 43, Pl. 2, Figs. 1-17, from the Upper Carbonifer-
ous in the suburbs of St. Louis.

480

SAWYER, A.—On the Origin of Ravines in the Prairies. By Amos Sawyer. 1 page. <Vol. III, page cxlix, November 2, 1874.

The results of observations on the prairies at Hillsboro are given.

481

SCHMIDT, A.—On the Forms and Origin of the Lead and Zinc Deposits of Southwest Missouri. By Adolf Schmidt, Ph. D. 7 pp. <Vol. III, page 246.

482

— Iron Manufacture in Missouri. A General Review of the Metallurgical Districts and their Resources. 12 pp. <Vol. III, page 261.

483

SHUMARD, B. F.—A Catalogue of the Palæozoic Fossils of North America. By B. F. Shumard, M. D. 74 pp. <Vol. II, page 334.

484

— Description of new Fossil Crinoidea from the Palæozoic Rocks of the Western and Southern Portions of the United States. 10 pp. 1 pl. <Vol. I, page 71. 1857.

Missouri localities of several species are given, and the name of *Poteriocrinus longidactylus*, Shum. described in Swallow's 2nd Report, changed to *P. Missouriensis*.

485

— Descriptions of New Species of Blastoidea from the Palæozoic Rocks of the Western States, with some Observations on the Structure of the summit of the genus *Pentremites*. 11 pp., 1 pl. <Vol. I, page 238.

This has a table of genera and species of Blastoidea found in Missouri and other western and southern States.

486

SHUMARD.—Observations on the Geology of the County of Ste. Genevieve, being an abstract from a Report made to the Missouri Geological Survey, in 1859. 12 pp. <Vol. I, page 404.

487

SHUMARD.—Notice of some new and imperfectly known Fossils from the Primordial Zone Potsdam Sandstone and Calciferous Sand Group of Wisconsin and Missouri. 7 pp. <Vol. II, page 101. 1863.

Describes the following:

Straparollis valvatiformis, page 105.

Murchisonia Ozarkensis, page 106.

M. carinifera, page 106.

Raphistoma subplana, page 106.

Orthoceras Ozarkensis, page 107.

Lituites complanata, page 197, all from the 3d Magnesian Limestone of Ozark County.

488

— Description of New Palæozoic Fossils. 6 pp. <Vol. II, page 108. 1863.

Describes the following:

Elæacrinus Kirkwoodensis, page 113, from the St. Louis Limestone, near Kirkwood.

489

SHUMARD, B. F. & SWALLOW, G. C.—Descriptions of New Fossils from the Coal Measures of Missouri and Kansas. By B. F. Shumard and G. C. Swallow. 32 pp. <Vol. I, page 198. 1858.

Describes the following:

Nautilus Missouriensis, Swallow, page 198, from the Hydraulic Limestone, Lower Coal Measures, Boone County.

Goniatites politus, Shum., page 199, from the Middle Coal Measures at Lexington.

G. minimus, Shum., page 200, from the Middle Coal Measures at Dover Landing.

Macrocheilus Missouriensis, Swallow, page 201, from the Lower Coal Measures of Howard County.

Naticopsis (Nerita) Pricei, Shum., page 202, from the Upper Coal Measures of Boone County.

Murchisonia minima, Swallow, page 203, from the Middle Coal Measures at Lexington.

Bellerophon Meekianus, Swallow, page 205, from the Middle Coal Measures at Lexington, and the Lower Coal Measures of Howard County.

Cypricardia plicatula, Swallow, page 205, from the Middle Coal Measures of Platte County, and Lower Coal Measures of Howard County.

Isocardius (?) curta, Shum., page 206, Coal Measures at Charboniere.

Cardium (?) Lexingtonensis, Swallow, page 206, from the Middle Coal Measures at Lexington.

Cardiomorphia Missouriensis, Shum., page 207, from the Coal Measures at Charboniere and Lexington.

Leptodomus Topykaensis, Shum., page 208, from the Coal Measures below the mouth of the Kansas River.

Allorisma cuneata, Swallow, page 210, from the Middle Coal Measures at Lexington.

A. lata, Swallow, page 210, from the same.

Lingula carbonaria, Shum., page 215, from the Coal Measures of Clark Co.

Orthis carbonaria, Swallow, page 218, from the Middle Coal Measures at Lexington.

Orthisina Missouriensis, Swallow, page 219, from the Upper Coal Measures at Dallas.

Rhynchonella (Camarophoria), Osagensis, Swallow, page 219, from the Upper Coal Measures of Missouri.

Rensia punctilifera, Shum., page 220, from the Upper Coal Measures of Andrain and Howard counties.

Discina Missouriensis, Shum., page 221, from the Middle Coal Measures at Lexington and Charboniere.

Pterioerinus rugosus, Shum., page 223, from the Coal Measures, Bluffs of the Missouri River and Putnam county.

P. hemisphericus, Shum., page 221, from the Coal Measures on Hinkston Creek, Boone county, and at Lexington.

Archaeodaris biangulatus, Shum., page 224, from the Middle Coal Measures at Lexington.

Phillipia Missouriensis, Shum., page 225, from the same.

P. major, Shum., page 226, from the Upper Coal Measures of Clinton county.

489

SWALLOW.—Grape Culture in Missouri. 13 pp. 1 pl. <Vol. I, page 156.

490

SWALLOW.—Descriptions of New Fossils from the Carboniferous and Devonian of Missouri. 26 pp. <Vol. I, page 635. 1860.

Describes the following:

Strophodonta navalis, page 635.

S. cymbiformis, page 635.

S. subcymbiformis, page 636.

S. Kemperi, page 636.

S. inflexa, page 637.

S. altidorsata, page 637.

S. Boonensis, page 638, all from the base of the Devonian, in Callaway County.

S. Callawayensis, page 638.

S. quadrata, page 639.

S. æquicostata, page 639, all from the Hamilton rocks of Callaway County.

Orthis Missouriensis, page 639, from the Chemung rocks of Cooper and Marion Counties.

Productus Callawayensis, page 640, from the Lower Devonian of Callaway County.

P. Cooperensis [sic], page 640, from the Chouteau Limestone of Cooper County.

P. magnicostatus, page 641, from the Coal Measures of Johnson County.

Spirifer Annæ, page 641, Hamilton Rocks, Callaway County.

- S. Osagensis*, page 641, from the Chemung rocks of Pettis County.
S. Missouriensis, page 643.
S. Cooperensis, page 643, (Illinois Survey, Vol. II, page 155, Pl. 14, Figs. 5a, 5b), both from the Chouteau of Cooper County.
S. Vernonensis, page 644.
S. Taneyensis, page 645, both from the Chemung rocks of Taney County.
S. Meekii, page 645, from the Encrinital of Pettis and Saline Counties.
S. lineatoides, page 645, from the Encrinital of Missouri.
S. Littoni, page 646, from the St. Louis Limestone of St. Louis Co.
S. Boonensis, page 646, from the Lower Coal Measures of Randolph and Monroe counties.
S. (Cyrtia) Hannibalensis, page 647, from the Lithographic Limestone of Marion county.
Cyrtia Missouriensis, page 647.
C. occidentalis, page 648.
Spirigera minima, page 649.
S. Fulltonensis, page 650, all the Hamilton Rocks of Callaway county.
S. Proutii, page 649, from the Chemung rocks of St. Louis Co.
S. Hannibalensis, page 649, from the same at Hannibal, Louisiana and Sulphur Springs, St. Louis Co.
S. Missouriensis, page 650, from the Coal Measures of Montgomery and Charlton counties.
S. Maconensis, page 651, from the same of the former county.
S. Charitonensis, page 651, from the Coal Measures of Montgomery and Charlton counties.
S. Jacksoni, page 651, from the Upper Coal Measures of Cass Co.
T. Hawnii, page 652, from the Coal Measures of Missouri.
Pentamerus Salinensis, page 652, from the Devonian at base of Chemung, Monticau Co.
Rhynchonella Warrenensis, page 653, from the Lower Devonian of Callaway Co.
R. ringeus, page 653, from the Encrinital Limestone of Callaway Co.
Retzia Osagensis, page 653, from the Chemung rocks of Cooper and Benton counties.
R. (?) Popenana, page 654, locality not stated.
Edmondia Marionensis, page 654.
Cardiomorpha (?) triangulata, page 655, both from the Chouteau Limestone of Cooper county.
Cardinia occidentalis, page 655, from the Chouteau Limestone of Cooper, Saline and Moniteau counties.
Solen (?) Missouriensis, page 655, from the ? of Pike Co.
Allorisma ensiformis, page 656, from the Coal Measures of Clay Co.
Conularia Marionensis, page 656, from Hannibal and Marion Co.
C. triplicata, page 657, from Marion Co., both from the Upper Hamilton Shales.
C. Missouriensis, page 657, from the Carboniferous Limestone of Cooper Co.
Trochus Missouriensis, page 657, from the Coal Measures of Jackson Co.
Littorina Wheeleri, page 658, from the Coal Measures of Monroe Co.
Nautilus Lawsii, page 658, from the Hamilton rocks of Callaway Co.
N. Gilpini, page 658, from the Coal Measures of Wayne Co.
Goniatis Morganensis, page 659, from the Chemung of Missouri.
G. (?) Holmesii, page 659, from the same of Cooper Co.

- G. Osagensis*, page 659, from the same of Cooper and Moniteau Cos.
Orthoceras Chemungense, page 660, from the Lithographic Limestone of Marion and Pike Cos.
O. Chemungense var. *Chouteauense*, page 660, from the Chouteau Limestone of Cooper Co.

491

SWALLOW.—Descriptions of some New Fossils from the Carboniferous and Devonian Rocks of Missouri. 20 pp. <Vol. II, page 81. 1863.

Describes the following :

- Pentremites Missouriensis*, page 81, from the Archimedes Limestone of Missouri.
Orthis Clarkensis, page 81, from the Keokuk Limestone of Missouri.
O. Cooperensis, page 82, from the Warsaw Limestone of Cooper Co. and Barrett's Station.
Orthisina occidentalis, page 82, from the Upper Coal Measures of Caldwell Co.
Terebratula gracilis, page 83, Upper Archimedes, St. Marys.
T. parva, page 83, from ? of Monroe and Cooper Cos.
T. arcuata, page 83, Kaskaskia Limestone, Ste. Genevieve Co.
T. brevilobata, page 84, Archimedes Limestone, Ste. Genevieve Co.
Rhynchonella arcistrostrata, page 84, and
R. perrostellata, page 85, both Archimedes Limestone, Cooper Co.
Spirifer translatus, page 85, Archimedes Limestone, St. Marys.
S. Kelloggii, page 86, Keokuk Limestone from ?.
S. lævigatus, page 86, Keokuk of Missouri.
S. latior, page 86, Chouteau Limestone, Cooper Co.
S. clarus, page 86, Archimedes, Ste. Genevieve Co.
Spirigera Plattensis, page 87, Upper Coal Measures, Nw. Mo.
S. Singletonii, page 87, Lower Coal Measures, Boone and Audrain Cos.
S. reflexa, page 88, 3rd Archimedes or Warsaw, Barrett's Station.
S. Clintonensis, page 89, 2nd Archimedes, Ste. Genevieve and Cooper Cos.
S. Americana, page 89, 2nd Archimedes, St. Marys.
S. caput-serpentis, page 90, Upper Coal Measures of Missouri.
S. formosa, page 91, Archimedes above Roonville.
S. euzonia, page 91, Archimedes, Cooper Co.
Productus Americanus, page 91, Upper Coal Measures of Harrison Co.
P. auriculatus, page 91, locality and horizon not given.
P. Fentonensis, page 93 from ? of St. Louis Co.
P. depressus, page 93, Keokuk Limestone, Fenton, St. Louis Co.
P. gradatus, page 93, Keokuk Limestone, Lewis and St. Louis Cos.
P. coræformis, page 94, Archimedes Limestone, Cooper Co.
Koninckina Americana, page 94, 3rd Archimedes Limestone, Barrett's Station, St. Louis Co.
Allorisma antiqua, page 95, Kaskaskia Limestone of Missouri.
Cypriocardia (?) Picensis, page 95, Coal Measures of Pike Co.
C. (?) Wheeleri, page 96, Upper Coal Measures, Caldwell Co.
C. (?) Chouteauensis, page 96, Chouteau Limestone, Cooper Co.
C. (?) occidentalis, page 96, from ?, Caldwell Co.
Pecten Broadheadi, page 97, Upper Coal Measures, Harrison Co.
Pinna Missouriensis, page 97, Ste. Genevieve Limestone of Missouri.

- Avicula magna*, page 98, Archimedes Limestone, Knox Co.
Gonularia Osagensis, page 98, Archimedes Limestone near Boonville.
Orthoceras Chesterense, page 98, Ste. Genevieve Limestone, near St. Marys.

492

SWALLOW.—Some New Varieties of *Spirifer lineatus*, Martin; *Spirifer cameratus*, Morton; *Spirifer Kentuckensis*, Shumard; *Spirifer Leidy*, Norwood and Pratten; *Spirifer increbescens*, Hall, and *Spirifer Keokuk*, Hall. 3 pp. <Vol. II, page 408. 1866.

Describes the following:

- Spirifer lineatus*, var *striato-lineatus*, page 408, from the Upper and Middle Coal Measures of Missouri.
S. Kentuckensis, var *propatulus*, page 409, Upper Coal Measures of Missouri.
S. Leidy, var *Chesterensis*, page 409, Ste. Genevieve Limestone.
S. Leidy, var *Merimacensis*, page 410, Archimedes, Barrett's Station.
S. increbescens, var *Americana*, page 410, Kaskaskia Limestone in Missouri.
S. Keokuk, var *Shelbyensis*, page 410, Archimedes Limestone, Shelby Co.

493

WHEELER, O. B.—The Secondary Base in Geodetic Surveys. By O. B. Wheeler. 12 pp. 1 folded plate. <Vol. V, page 21.

494

WISLIZENUS, A.—Was Man cotemporary with the Mastodon? By A. Wislizenus, M. D. 4 pp. <Vol. I, page 168.

495

WORTHEN, A. H.—Abstract of "Review of some points in Dr. B. F. Shumard's Report on the Geology of Ste. Genevieve County, Mo." By A. H. Worthen. 2 pp. <Vol. I, page 696.

496

KOCH.—Remarks concerning Mastodon Remains and arrow head found in Missouri, and on Dr. Wislizenus' paper, by Dr. Koch. 2 pp. <Vol. I, page 116.

SCHOOL OF MINES QUARTERLY.

497

KEMP, J. F.—Notes on the Ore Deposits, and Ore Dressing in South-eastern Missouri. By J. F. Kemp, E. M. 8 pp. <Vol. IX, page 74. 1887.

498

KEMP, J. F.—Notes on Lead-Smelting in Southeastern Missouri. By J. F. Kemp. 8 pp. <Vol. IX, page 212. 1888.

499

MAYNARD, G. W., AND KUNHARDT, W. B.—On the Dressing of Non-Bessemer Ores. By G. W. Maynard and W. B. Kunhardt. 18 pp. <Vol. IX, page 145.

500

NEWBERRY, J. S.—The Genesis of the Ores of Iron. By J. S. Newberry. 17 pp. <Vol. 1, Nov. 1880.

SEDALIA NATURAL HISTORY SOCIETY BULLETIN.

501

HAMBACH, G.—Pettis County Pentremites. By Dr. G. Hambach. <Bulletin No. 1, Sedalia, Mo., 1885, pp. 29-30.

The descriptions of *Pentremites Sampsoni* and *Condites campanulatus* from Pettis county, are copied from the Trans. St. Louis Acad. Sci.

UNITED STATES ASSOCIATION OF CHARCOAL IRON WORKERS' JOURNAL.

502

BIRKENBINE, J.—Narrative of the Fifth Annual Meeting of the United States Association of Charcoal Iron Workers, held at St. Louis, Mo. (Aug. 30, 1884.) (John Birkenbine, Secretary.) 12 pp. <Vol. V, page 291.

Contains descriptions of the iron mines and furnaces in the neighborhood of St. Louis.

503

POTTER, W. B.—The Iron Ore Regions of Missouri. By W. B. Potter. 18 pp. 1 folded map of the iron regions of Missouri. <Vol. VI, page 23.

WESTERN JOURNAL AND CIVILIAN.

(A magazine published in St. Louis from 1848 until 14 volumes and 8 numbers were issued.)

504

ANONYMOUS.—Missouri Iron, Shipments from Ste. Genevieve, June 1 to December 1, 1853. (From Ste. Genevieve Plaindealer.) 1 p. <Vol. XI, page 290.

505

BUCKLIN.—Report of the Engineer on the Preliminary Surveys and Location of the Hannibal & St. Joseph R. R. By James M. Bucklin, Chief Engineer. <Vol. X. pp. 272-277. 1853.

This has an account of the minerals of North Missouri, with a section of seventy miles of the North Missouri coal field.

506

COBB, H.—Geological Survey of Missouri. By H. Cobb. 2 pp. <Vol. IX, page 319.

507

— Southeast Missouri. By H. Cobb. <Vol. IX, pp. 313-318.

508

— Manufacture of Missouri Iron. 2 pp. <Vol. XI, page 370.

509

— Missouri Railroad Iron. 3 pp. <Vol. XI, page 442.

510

— Missouri Coal. <Vol. XI, page 273.

511

— Geological Survey of Missouri. <Vol. XII, o. s. Vol. XII [6] n. s., pp. 1-7. 1854.

512

EDITORIAL.—New Madrid Earthquake. 5 pp. <Vol. XVII, page 586.

513

— Railroad from St. Louis to New Orleans. Missouri & Arkansas Railroad. U. S. Survey, etc. <Vol. VIII, pp. 408-422. 1852.

This has a full account of the Joshua Barney survey, the report of which was published by the government at Washington.

514

KING, H.—Geological Survey of the State of Missouri. By Dr. H. King. 18 pp. <Vol. III, page 12.

515

— Geological Survey of the State of Missouri. 8 pp. <Vol. III, page 76.

516

— Some Remarks on the Geology of the State of Missouri. 15 pp. (Read before the A. A. A. S. May, 1851, and published in Proceedings.) <Vol. VIII, page 228.

517

MAUGHAS, M. M.—Geological Researches in Missouri. By Dr. M. M. Maughas. (Read before the Missouri Hist. & Phil. Ass'n, Jan., 1853.) 15 pp. <Vol. IX, p. 382.

518

MEMORIAL.—St. Louis & Iron Mountain Railroad Memorial. To the City Council of the City of St. Louis. <Vol. X, pp. 277-281.

This is a memorial prepared by a committee of the Board of Directors of the railroad to solicit a subscription from the city to the railroad, and it details the mineral advantages to the city in opening up the country to be traversed by the railroad.

519

MOSELY, W. S.—New Madrid, Missouri. By Wm. S. Mosely. 6 pp. <Vol. III, p. 385.

This describes the region affected by the earthquake of 1811-12.

520

MOSELY.—Lead Mines in Southwest Missouri. 3 pp. <Vol. IV, page 411.

521

PROUT, H. A.—The Geology and Mineral Resources of the State of Missouri. By Dr. H. A. Prout. 4 pp. <Vol. I, page 6.

522

PROUT.—On the Geology of the Valley of the Mississippi. 10 pp. <Vol. I, page 243.

523

PROUT.—On the Economic Geology of the State of Missouri. 11 pp.
<Vol. I, page 429.

524

RISK, T. F.—Geological Survey of Missouri. By T. F. Risk. 5 pp.
<Vol. II, page 333.

525

ROZIER, F. A.—Submerged Lands of Missouri. 6 pp. <Vol. III, pp.
391-396.

This is a report presented to the "Southwestern Convention," held at
Memphis in 1845, signed by Firmin A. Rozier, Chairman.

526

SHEPARD.—Remarks of Prof. Shepard of Yale College, on the Iron
Mountains in Missouri. 3 pp. <Vol. VIII, page 140.

527

SINGLETON, WM. R.—Iron Mountain and Iron Works of Missouri. By
Wm. R. Singleton, Principal Engineer of Ste. Genevieve, Iron
Mountain and Pilot Knob Plankroad. 7 pp. <Vol. VIII, page 136.

528

TARVER, M.—Manufacture of Iron in St. Louis, Iron Mountain and
Iron Ore in Missouri. Causes hindering the Production of Iron in
Missouri, &c., &c. By M. Tarver. 4 pp. <Vol. I, page 36.

529

TARVER.—Blow's White Lead and Oil Factory. 1 page. <Vol. I,
page 99.

530

TARVER.—Manufactures in St. Louis. Lead Pipe and Sheet Lead
Manufactory, Copper Work, Bell and Brass Foundry, etc. 1 page.
<Vol. 1, page 445.

531

WOOLFORD, F.—Mines and Mining. Mineral Resources of Washington
County, Missouri. By Frederick Woolford. 3 pp. <Vol. 1, page
163.

532

WOOLFORD.—Clays and Minerals of Missouri. 3 pp. <Vol. I, page
192.

WESTERN QUARTERLY.

533

ANONYMOUS.—New Mineral Discoveries. <Vol. I, No. 1, July 1868, pp. 89-90.

This has an account of the discovery of copper and antimony in Cedar county, copied from the *Missouri Democrat*, and a notice of the Webster county lead mines, from the *Springfield Patriot*.

534

EDITORIAL.—The Advantages and Resources of Missouri. <Vol I, No. 1, July, 1868, pp. 4-8.

This relates principally to the mineral resources.

535

— Will Mining in Missouri pay ? <Vol. I, No. 1, July, 1868, pp. 24-27.

536

— Tin in Missouri. <Vol. 1, No. 1, July, 1868, pp. 31-34.

PART V.

Miscellaneous Publications.

ALPHABETICAL LIST.

537

ALLEN, T.—Missouri: its History, Characteristics, Resources and Present Condition. A Discourse delivered at the request of the U. S. Centennial Commission, and by appointment of the Governor of the State, in the Judges' Hall of the International Exposition. Centennial Celebration, at Philadelphia, July 28, 1876. By Thomas Allen, of St. Louis. Philadelphia: Printed for the Missouri Commission, 1876, 29 pp.

The mineral resources and kindred subjects are treated of on pp. 20-26.

538

ANONYMOUS.—A Hand-book of Northwest Missouri. Published by the Northwest Missouri Immigration Society. 1889. 144 pp., illustrations.

The minerals of the counties of the part of the State described are shown in the county descriptions.

539

— [R. B.]—View of the Valley of the Mississippi, or the Emigrant's and Traveler's Guide to the West. * * * * Second Edition, Philadelphia: Published by H. S. Tanner. 1834. 12°, 372 pp.

Missouri and its Minerals are given on pp. 235-250.

540

ANONYMOUS.—Mineral Wealth of Missouri. Iron Mountain and Pilot Knob, 2 pp., 2 plates. <History of St. Louis, Commercial Statistics, &c. From the St. Louis Republican, January 10, 1854. St. Louis, Mo. 1854. pp. 41-42.

The two plates give views of Iron Mountain and Pilot Knob.

541

— Prospectus, Charter and By-Laws of the Stanton Copper Mining Company. Organized, 1854. Treasurer's office, No. 10 Chesnut Street, St. Louis, Mo. St. Louis: Printed at the Republican Office, 1855. 35 pp.

The geology of the region about the mine in Franklin county is given.

542

— Der Eisenberg am Missouri. 1 page. <Die Natur. Dr. Otto Ule und Dr. Karl Muller. Vol. V, No. 26, page 208. 1856.

The above is a communication signed B.

543

— Southern Missouri, its Resources and Elements of Wealth, being a general description of the soil, face of the country, productions, improvements, &c., together with a copy of the Graduation Act, and an Essay of Prof. G. C. Swallow, State Geologist of Missouri, on the Culture of the Grape, by Leffingwell, Clark & Co. Plates. 16 pp. 1859.

544

— Sectional maps showing the location of One Million Acres Choice Agricultural and Mineral Lands on the line of the South Pacific Railroad in the State of Missouri, with statistics of the counties and towns, and description of the lands, price per acre, etc. * * * St. Louis. Land Department South Pacific Railroad Company, 1868, 12°, 40 pp. Map and many plates.

545

— Proceedings of a Convention of Delegates for the Promotion of Internal Improvements within the State of Missouri, held at the city of St. Louis, on the twentieth day of April, 1836. St. Louis: Printed by Charles Keemle. 1836. 30 pp.

The development of the mineral resources of the State was one reason urged for the State's assisting in the building of railroads.

546

ANONYMOUS.—Newton County, Missouri. Its Agricultural, Mineral and Manufacturing Interests, Educational and Industrial Advantages. The Home for the Emigrant. Neosho, Mo. Printed at the Neosho Journal Book and Job office, 1873. 16°, 8 pp.

This was issued by the Newton County Immigration Society.

547

— The Mineral Wealth of Southwest Missouri. The Lead and Zinc Mines of Granby, Minersville, Joplin, Grove Creek, Stevens Mines, Thurman, Conwell, Conley, and others. Published by Lloyd & Bauman, Joplin, Mo. 1874. 64 pp.

There is an accompanying Map of the Lead Region of Southwest Missouri, by Lloyd & Bauman.

548

— A Sectional Map Book of the Atlantic and Pacific Railroad lands.
* * * St. Louis, Mo. 31 pp. Maps. 1874. (?)

This gives an account of the mineral lands in the part of the State near the railroad.

549

— Washington County, Missouri. Its Agricultural, Mineral and Manufacturing Resources. Independent Print, Potosi, Mo., May, 1880. 12°, 9 pp.

550

— Carthage and Jasper County. What and where they are. * *
Carthage, Missouri, 1887. 58 pp. Map and many illustrations.

This was issued by Carthage Board of Trade. It has an account of the Mining Interests, Lead, Zinc and Coal, pp. 38-43.

551

— Iron and Steel. An account of another Holiday outing of the Boys and Girls. By a Man of the Great Rock Island Route, Chicago. 1888. 98 pp. 12°.

This has an account of the Iron Mountain Iron Mines.

552

— Pleasanton, Kansas, its Coal Fields, Resources and Advantages. Herald Job Office, Pleasanton, Kas. 32 pp. 12 figs.

This was published by the Pleasanton Commercial Club, and has an account of the Rich Hill mining region.

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553

ANONYMOUS.—*Hand-Book of Macon County, Missouri. The Blue Grass region of North America. Macon Mo. 1888. Folio. Pamphlet.*

The coal mines and other mineral resources of the county are described on pp. 3-5 and 25.

554

— *The Good Luck Mining and Smelting Co., of Aurora, Missouri. Prospectus, 4 pp. 16mo. [1890.]*

This gives various facts in relation to the lead and zinc mines of Aurora.

555

ARNOLD, A.—*Morgan County, Missouri. Pen Pictures of its unsurpassed advantages of soil, climate, timber, water power and rich mineral resources, schools, society, etc. [By A. Arnold.] Versailles, Mo. 1887. 20 pp.*

556

ATWATER, C.—*Remarks made on a Tour to Prairie Du Chin; thence to Washington City, in 1829. By Caleb Atwater, Late Commissioner employed by the United States to negotiate with the Indians of the Upper Mississippi for the purchase of Mineral Country; and author of Western Antiquities. Columbus, O. Published by Isaac N. Whiting. 1831. 12°. 296 pp.*

An account of his travels in Missouri is given at pages 40-56.

557

BECK, L. C.—*Gazetteer of Missouri and Illinois. By Lewis C. Beck, Albany, N. Y. 1823. **

There are items on many pages relating to the geology and mineralogy of Missouri.

558

BELTRAMI, J. C.—*A Pilgrimage in Europe and America, leading to the Discovery of the Source of the Mississippi and Bloody River; with a Description of the whole source of the former, and of the Ohio. By J. C. Beltrami, Esq. Formerly Judge of a Royal Court in the ex-Kingdom of Italy. In two volumes. London. Printed for Hunt and Clark, York street, Covent Garden. 1828.*

Letter XIII, pp. 100-125 of the second volume, was written from St. Louis, and about Missouri.

559

BLISS, N. W.—East-South Missouri. The counties immediately adjoining and contiguous to the great river and the city of St. Louis. Their resources—advantages—soils—climate—products—mineral deposits—water powers, etc. By N. W. Bliss. Published by Union Mining and Smelting Company, Old Mines, Washington County, Mo., and Washington Land and Mining Company, Kingston Furnace, Washington County, Mo. St. Louis address: C. S. Greeley, President U. M. & S. Co. and W. L. & M. Co., 620 N. Second Street, St. Louis, Mo. Issued under the authority and with the indorsement of the Missouri Immigration Society. (St. Louis. 1882.)

560

BOARD OF IMMIGRATION¹.—Hand-Book of Missouri, embracing exhibits of the agricultural, etc., etc.—Published by the Missouri Immigration Society, issued by the Missouri State Board of Immigration. St. Louis: Times Printing House, Fifth and Chestnut Streets. 1881. 278 pp.

This is also found with a title page which does not show that it was originally issued by the State Board.

561

BRACKENRIDGE, H. M.—Views of Louisiana: together with a Journal of a Voyage up the Missouri River, in 1817. By H. M. Brackenridge, Esq. Pittsburgh. Printed and Published by Cramer, Spear and Eichbaum. Franklin head office. 1814. 304 pp.

An account of the soil and face of the country is given on pp. 103-110, and of the Lead Mines of Ste. Genevieve on pp. 146-155.

562

—Recollections of Persons and Places in the West. By H. M. Brackenridge, a native of the Ohio. Philadelphia: James Kay, Jun. and Brother. [1835.] 18°. 244 pp.

The author lived at Ste. Genevieve, and he starts on his travels from there, and returns by way of New Madrid.

¹This title belongs properly with the reports of the Missouri State Board of Immigration; but it was obtained too late for insertion in its proper place.

563

BRADBURY, J.—Travels in the Interior of America, in the years 1809, 1810 and 1811 : including a description of Upper Louisiana, together with the States of Ohio, Kentucky, Indiana and Tennessee, with the Illinois and Western Territories, and containing remarks and observations useful to persons emigrating to those countries. By John Bradbury, F. L. S. London, * * * * * Liverpool, * * * * * 1817.

An account of the New Madrid earthquake is given on pp. 199-207, and the minerals of the State are also noticed.

564

BRADFORD.—Notes on the Northwest, or Valley of the Upper Missouri, comprising . . . and Northern Illinois and Missouri. New York and London. 1846. 12°. 302 pp.

Pages 200-270 are on the geology of the region, including Missouri.

565

BROADHEAD, G. C.—Geological Report upon the Mineral Lands of Major B. H. Melton. By G. C. Broadhead, Former State Geologist of Missouri. Sedalia. 1880. 12 pp.

566

—(The geology of Missouri.) <The American Cyclopædia. Appleton. 1875. In article on "Missouri." pp. 665-666.

I am informed by Prof. Broadhead that he wrote the part of the article above mentioned.

567

BROCKETT.—Our Western Empire; or the New West Beyond the Mississippi. Illustrations and maps. Phil. 1882. 1312 pp.

Chapter XII, pp. 927-955, has an account of Missouri, including its geology.

568

BUCKLIN, J. M.—Report of the Preliminary Surveys and Location of the Hannibal and St. Joseph Railroad. By James M. Bucklin, Chief Engineer.*

This describes the coal beds along the line of the road.

569

BUSKETT, J. L.—A Short Description of the Lost Hill and Evans Lead Mines in Franklin County, Mo. (By J. L. Buskett, 614 Pine Street. 1873 or later.) 12°. 8 pp.

570

CAMPBELL, R. A.—Material Wealth. The Resources, Productions, Possibilities of Missouri. By Robert Allen Campbell, C. E. Author of "Campbell's Gazetteer of Missouri," etc. <Switzler's History of Missouri. Part IV. 1879.

571

CHRISTY, J. M.—Letters on Geology: being a series of communications addressed to Dr. John Locke, of Cincinnati, giving an outline of the Geology of the West and South West, together with an essay on the Erratic Rocks of North America, addressed to M. De Verneuil. Illustrated by Geological sections and Engravings of some rare Fossils. By David Christy. Rossville: J. M. Christy. Main St. 1848.

572

CRAWFORD, A. L. & SCOTT, WM. L.—Prospectus of the Iron Mining Comp'y of Missouri, and the St. Louis, Salem & Little Rock R. R. Erie Observer Power Presses. 1872. (A. L. Crawford, New Castle, Pa. Wm. L. Scott, Erie, Pa.) 12°. 12 pp.

573

DADDOW, S. H. & BAUMAN, B.—Coal, Iron and Oil; or, the Practical American Miner. * * * * By Samuel Harriss Daddow and Benj. Bauman. Pottsville, Pa. 1866.

There is an account of the iron mines of Missouri on pages 550-552.

574

DANA, J. D.—Manual of Geology, . . . with special reference to American Geological History. By James D. Dana. Phil. 1865. Revised edition.

This contains many references to the geology of Missouri.

575

DAVIS, W. B. & DURRIE, D. S.—Physical Geography of Missouri. 16 pp. <An illustrated History of Missouri, comprising its early record, and civil, political, and military history from the first exploration to the present time, etc. By Walter Beckford Davis and Daniel S. Durrie, A. M. St. Louis: A. J. Hall & Co. 1876. Chapter XXIV, pages 228-245.

This has an account of the geology and minerals of the state, and a portrait of Prof. G. C. Swallow.

576

FARMER, J.—Map of the Most Important part of the Lead Regions near the Mississippi river. John Farmer. 1836.

577

FEATHERSTONHAUGH, G. W.—Excursion through the Slave States, from Washington on the Potomac to the frontier of Mexico ; with sketches of popular manners and geological notices. By G. W. Featherstonhaugh, F. R. S., F. G. S. New York: Harper & Brothers. 1844. 168 pp.

Chapters XVI to XXIII, pages 82-88, are about Missouri, including the results of trips to the iron and lead mines.

578

FLINT.—History and Geography of the Valley of the Mississippi. 2nd Edition. Cincinnati. 1832.

579

FORSHEY, C. G.—Delta of the Mississippi river. By Col. C. G. Forshey of Louisiana. (*)

The author was of the opinion that the proper delta of the Mississippi extended to within a few miles of Cape Girardeau.

580

FOSTER.—The Mississippi Valley : its Physical Geography, including sketches of the Topography, Botany, Climate, Geology and Mineral Resources ; and of the Progress of Developement in Population and Material Wealth. Illustrated by maps and sections. Chicago : S. C. Griggs & Co. 1869. 443 pp.

581

GODFREY, C. O.—What shall we burn ? A Treatise on the Bituminous Coals of the West. Office of C. O. Godfrey, Hannibal, Missouri. St. Louis. 1872. 14 pp.

582

GURLEY, WM. F. E.—New Carboniferous Fossils. Bulletin No. I. By Wm. F. E. Gurley. September 24, 1883.

The following are described ; there are no figures :

Crania Rowleyi, page 3.

Cornulites carbonarius, page 8.

Spirorbis Kinderhookensis, page 9, all from the Kinderhook division of the Sub-Carboniferous, Pike county.

Bellerophon textiliformis, page 6.

Discites Toddanus, page 7, both from the Upper Coal Measures, Kansas City.

583

GURLEY.—New Carboniferous Fossils. Bulletin No. 2. February 25, 1884. 12 pp.

The following are described :

Ptychostylus heterocostalis, page 5.

Lepetopsis Parriahi, page 7, both from the Upper Coal Measures at Kansas City.

Ptychostylus subtumidus, page 6, from the Kinderhook Shales, Pike County.

584

GWYNN, J. K.—Minerals and Mining. <Southwest Missouri. Prepared and published by the Southwest Missouri Immigration Society. J. K. Gwynn, Secretary, Clinton, Mo. St. Louis. 1888. pp. 15-18.

There are also reports of the minerals of each county that is described in the pamphlet.

585

HALL, J.—Supplementary Note on the Potsdam Sandstone. James Hall. <In "Contributions to Palæontology," in the Sixteenth Annual Report of the Regents of the University of New York for 1863, pp. 210-220.

The Magnesian Limestones of Missouri are considered in this paper.

586

HARLAN, R.—Medical and Physical Researches by Richard Harlan, M. D. Phil. 1835.

Contains description of *Bos Pallassii*, DeKay, from New Madrid, on page 253.

587

HAWORTH, E.—A Contribution to the Archæan Geology of Missouri. An inaugural dissertation presented to the Board of University Studies of the Johns Hopkins University, with an application for the degree of Doctor of Philosophy, by Erasmus Haworth, M. S. Minneapolis, Minn. The University Press, State University. 1888. 40 pp.

This was also published in Johns Hopkins University Circulars, Vol. VIII, No. 65, and in the American Geologist.

588

HAYWARD, W. W.—Moniteau County, Missouri, its Geographic Features, Agricultural and Mineral Resources, etc., etc. Published by W. W. Hayward & Co., California, Missouri, July, 1875. 12mo, 32 pp.

An account is given of the mines of coal, zinc, lead, barytes, etc., pp. 11-16.

589

HEWITT, A. S.—A Century of Mining and Metallurgy in the United States. Centennial Address of Hon. Abram S. Hewitt, President elect of the American Institute of Mining Engineers. Phil. June 20, 1876. 33 pp. <Vol. V, Trans. Amer. Inst. Mining Eng'rs, pp. 164-193.

590

HOGAN, J.—Thoughts about the City of St. Louis, her Commerce and Manufactures, Railroads, &c. First Published in the Missouri Republican, St. Louis, Mo.; Republican Steam Press Print, 1854. 80 pp. 15 full-page and 1 folded plate.

These "Thoughts" are signed J. H., and were written by John Hogan. Nos. XXI, XXII and XXIII, pages 40-47, treat of the iron, lead, copper, coal and other minerals of the State.

591

KING, H.—The Grand Tower Iron Works, Perry County, Missouri. Incorporated June 11, 1853; capital \$500,000. New York: Printed by Edward O. Jenkins, No. 114 Nassau Street. 1853. 20 pp.

This contains a geological report on the locality by Dr. H. King.

592

— Report on an examination of the estate belonging to the St. Louis and Birmingham Iron Mining Company. By order of the Board. St. Louis. Printed at the St. Louis Times Book and Job Office. 1852. 18 pp.

This contains a geological report by Dr. H. King.

593

KING, ET AL.—Charter and By-Laws of the St. Louis and Birmingham Iron Mining Company, together with reports on an examination of the estate. New York: Baker, Godwin & Co., Printers, corner Nassau and Spruce Streets. 1853. 35 pp.

This contains geological reports by Dr. H. King and J. D. Whitney, and analyses of ore by Charles T. Jackson.

594

KING.—The Great South. Some notes on Missouri: The Heart of the Republic. By — King. <Scribner's Monthly, July, 1874, Vol. VIII, pp. 257-283. 26 figs.

This has descriptions and illustrations of Iron Mountain and Pilot Knob.

595

KIRKWOOD.—Report of the Chief Engineer. January 10, 1851. <First Annual Report of the Board of Directors of the Pacific Railroad; and the Report of the Chief Engineer upon the Preliminary Surveys. St. Louis, Mo.: Printed at the Republican Book and Job Office. 1851.

This has a map and section showing elevations along the different routes surveyed, with descriptions of these routes and of the country through which they run.

596

KOCH.—Fossil Remains. 8 pp. 1 Pl. No title page. No name.

This gives an account of the discovery of antediluvian remains made in May, 1831, on the premises of Capt. Palmer, 22 miles south of St. Louis, in Jefferson county; also a description of other large bones disinterred in 1838 in Gasconade county. The pamphlet is evidently by Dr. Koch, and was probably published before 1841. The copy examined is in the St. Louis Public School library, and was formerly in that of Dr. Shumard.

597

KOCH, A.—Description of the Missouriium or Missouri Leviathan, together with its supposed habits; Indian traditions concerning the location from whence it was exhumed; also, comparisons of the Whale, Crocodile and Missouriium with the Leviathan as described in the 41st Chapter of the Book of Job; by Albert Koch. St. Louis. 1841. 16 pp.

598

— Description of the Missouriium theristocaulodon (Koch), or Missouri Leviathan (Leviathan Missouriensis), together with its supposed habits, and Indian Traditions concerning the location from whence it was exhumed; also, comparisons of the Whale, Crocodile and Missouriium with the Leviathan, as described in the 41st Chapter of the Book of Job. By Albert Koch. Fourth Edition. London: E. Fisher, 33, Cannon Street, City, 1842. 23 pp. 1 Pl.

599

KOCH, A.—Description of the *Missourium Theristocaulodon* (Koch), or *Missouri Leviathan* (*Leviathan Missouriium*), together with its supposed habits and Indian traditions; also, Comparisons of the Whale, Crocodile and *Missourium* with the *Leviathan*, as described in the 41st Chapter of the Book of Job; by Albert Koch. Fifth Edition enlarged. Dublin. 1843. 28 pp. (*)

600

— Die Bissenthiere der Urwelt oder das neuentdeckte *Missourium Theristocaulodon* (Sichelzahn aus Missouri), und die *Mastodontoiden* im Allgemeinen und Besondern, nebst Beweisen, dass viele, uns durch ihre Ueberreste bekannt gewordene Thiere nicht präadamitisch, sondern Zeitgenossen des Menschengeschlechts waren. Eine auf eigene Entdeckungen und Beobachtungen gegründete Abhandlung von Dr. Albert C. Koch, Mitglied mehrer naturwissenschaftlichen Gesellschaften. Mit 8 Tafeln Abbildungen. Berlin. Verlag von Alexander Duncker, Königl. Hofbuchhandler. 1845. 99 pp.

601

— Lithographic print of the *Missourium*, issued at Dresden. (*)

602

— Description of the *Hydrargos Sillimanii*: (Koch), a gigantic fossil reptile, or Sea Serpent: lately discovered by the author, in the state of Alabama, March, 1845. Together with some geological observations made on different formations of the rocks, during a Geological tour through the Eastern, Western and Southern parts of the United States, in the years 1844–1845. By Doctor Albert C. Koch, Corresponding member of the Societies of Halle, and of Dresden, &c. The Bones of this Monstrous Serpent measure 114 feet in length, and weigh seven thousand five hundred pounds. New York, 1845. 16 pp. 1 Pl.

The author's journey extended into Missouri, and he gave some accounts of the geology and of the fossils found.

603

LATROBE, C. J.—The Rambler in North America: MDCCCXXXII–MDCCCXXXIII. By Charles Joseph Latrobe. London. MDCCCXXXV.

His travels and observations in Missouri are given in Vol. I, pp. 115–163.

604

LAWRENCE, B.—A Concise Description of the Geological Formations and Mineral Localities of the Western States; designed as a Key to the Geological Map of the Same. By Byrem Lawrence. 16 mo. 44 pp. Boston. 1843.

The iron and lead of Missouri are referred to on pages 26-28.

605

LYELL, C.—A Second Visit to the United States of North America. By Sir Charles Lyell, F. R. S. In two volumes. New York. 1849.

In the second volume, pages 172-182, there is an account of the earthquake region about New Madrid.

606

— Principles of Geology, or the Modern Changes of the Earth and its inhabitants considered as Illustrative of Geology. By Sir Chas. Lyell, Bart., M. A., F. R. S. Tenth and entirely revised edition. London. 1868.

In Vol. II, pp. 106-110, of the above edition, there is an account of the New Madrid earthquake region. Pages not noted in other editions.

607

MACFARLANE, J.—An American Geological Railway Guide, giving the Geological Formation at every Railway station, with Notes on interesting places on the Routes, and a Description of each of the formations. By James Macfarlane, Ph.D. New York. D. Appleton and Company. 1879.

The account of the geological formations and localities of Missouri was written by Prof. G. C. Broadhead, and is given on pages 154-158.

A revised and enlarged edition containing 370 pages, edited by James R. Macfarlane, was issued in 1890.

608

— The Coal Regions of America: their Topography, Geology and Development. By James Macfarlane, A. M. With maps. New York: D. Appleton and Company. 1873.

An account of the Missouri coal region is given on pages 469-477.

609

MARCOU, J.—*Geology of North America; with two Reports on the Prairies of Arkansas and Texas, the Rocky Mountains of New Mexico, and the Sierra Nevada of California, originally made for the United States Government. By Jules Marcou. Zurich. 1858. Folio.*

The geology of Missouri is to some extent included in this report. There are other editions of the work besides the one here given.

610

MILLER, S. A.—*North American Geology and Palaeontology for the use of Amateurs, Students and Scientists. By S. A. Miller. Cincinnati, Ohio. 1889. 664 pp. Illustrations.*

The geology of Missouri is described on pages 33, 41, 45, 58, 59, 61 and 66-77.

611

MILLS, J. E.—*Geological Report on the Mine La Motte Estate, the property of Hon. Rowland Hazard, situated in St. Francois and Madison Counties, Missouri. With accompanying Map and Diagrams. By James E. Mills, B. S., Consulting Geologist. 1877. G. W. & O. B. Colton & Co., New York. 4to, 51 pp.*

This has sections, diagrams and map. Folded Diagram No. 1, illustrating the General Geology of the Tract. Scale 1:60,000. One inch to 5,000 feet. Two folded diagrams of sections.

612

NEWBERRY, J. S.—*The Iron Resources of the United States. By J. S. Newberry.*

This is Article III, pages 784-789 of the *International Review*, November-December, 1874.

613

NUTTALL, M.—*A journal of travels into the Arkansas Territory during the year 1819. By M. Nuttall (7), 1821.**

614

OWEN, R.—*A History of British Fossil Mammals and Birds. By Richard Owen, London. 1846.*

The Missouri mastodon, discovered by Dr. Koch, and now in the British Museum, is figured on page 298, and is described on pages 290-298.

615

O'SULLIVAN & MORLEY.—Report of O'Sullivan & Morley, Engineers of the St. Louis & Iron Mountain Railroad Company. <Second Annual Report of the Directors of the Road. St. Louis. 1854.

616

PATTEN, J. H.—The Natural Resources of the United States. By J. Harris Patten, M. A. New York. 1881. 16°.

617

PEALE.—Lists and Analyses of the Mineral Springs of the United States. A Preliminary Study. Bulletin No. 32 of the Geological Survey. Washington. 1886.

This contains references to the mineral springs of Missouri on pages 164-170.

618

PEASE, G.—Brief Statements respecting Mineral Deposits in the States of Missouri and Illinois. [By Gales Pease.] Boston. 1839. 12 pp.

There is a map mentioned as accompanying this, but it is not found in the copy in my library.

619

PARKER, N. H.—The Missouri Hand-Book, embracing a full description of the State of Missouri; her Agricultural, Mineralogical and Geological character; her Water Courses, Timber Lands, Soil and Climate; * * * * * Location of Valuable Mines and Mineral Lands. * * * By Nathan H. Parker. * * * Saint Louis. P. M. Pinckard, Nos. 78 and 80 Pine Street. 1865. 12°, 162 pp. Map of the State.

620

— Missouri as it is in 1867: an Illustrated Historical Gazetteer of Missouri, embracing the Geography, History, Resources and Prospects, the Mineralogical, etc., etc. By Nathan H. Parker. Phil. 1867. 458 pp.

621

— Geological Map of Missouri, by Nathan H. Parker. 1865.

622

PARKER, S.—Journal of an Exploring Tour beyond the Rocky Mountains, under the direction of the A. B. O. F. M., performed in the years 1835, 36 and 37; containing a Description of the Geography, Geology, Climate and Productions, and the number, manners and customs of the natives. With a map of Oregon Territory. By Rev. Samuel Parker, A. M. Ithaca, N. Y. Published by the author. 1838.

His journey through Missouri is described on pages 20-34, but this part of the work contains very little geology.

The fifth edition was published at Auburn in 1846.

623

PERKINS, J. H. and PECK, J. M.—Annals of the West: embracing a concise account of principal events which have occurred in the Western States and Territories from the discovery of the Mississippi valley to the year eighteen hundred and fifty. Compiled from the most authentic sources for the projector. First edition. By James H. Perkins. Second edition, revised and enlarged, by J. M. Peck. St. Louis: Published by James R. Alback. Chambers & Knapp, Printers, 1851.

Account of the New Madrid earthquake. pp. 586-590. The account is partly from Dr. Hildreth. [See also Senator Linn's letter in Wetmore's Mo. Gazetteer, 132-142; Drake's Picture of Cincinnati; Flint's Recollections; American Pioneer, 1-129; Travels in the Interior of America, by John Bradbury. pp. 199-207.

624

PHILLIPS, J. V.—Report of J. Van Cleve Phillips, Geologist and M. E. on Reeds' Mineral Tract, located at Reeds, Jasper county, Missouri. Also Several Opinions of Distinguished Geologists and M. E.'s on Mineral Properties on said tract, etc. Carthage, Mo.

625

— Report on the Geology of the Mineral District contiguous to the Iron Mountain Railroad. By J. V. Phillips. St. Louis. 1859. 14 pp., map and section.

This contains a Geological map showing the mineral region contiguous to the Iron Mountain Railroad and its proposed extension, surveyed by J. V. Phillips. Constructed and drawn by J. T. Fiala. St. Louis Mo. 1859. Scale 2 inches to 6 miles. The vertical section is through Iron Mountain and Pilot Knob from Greenville to Bailey's, 100 miles.

626

PHILLIPS, J. A.—A Treatise on Ore Deposits. By J. Arthur Phillips. F. R. S., with numerous illustrations. London. 1884.

Accounts of the Copper, Iron, Lead and Zinc of Missouri are given.

627

POST, G. T.—Report showing the Necessity, Feasibility and Prospects of the Central Missouri Railway. By the President. [Geo. T. Post.] October, 1885. 25 pp.

This describes the coal field along the line of the road.

628

POTTER, WM. B.—Report on the Cornwall Mine & Smelting Works at Ste. Genevieve, Missouri, by William B. Potter, E. M., Professor of Mining and Metallurgy at Washington University. Riverside Printing House, 302 N. Main St., St. Louis. 1882.

629

PROUT, H. A.—The Advantages of a Geological Survey of the State of Missouri. By H. A. Prout, M. D. St. Louis: Printed by W. B. Foster—Times Office. 1851. 29 pp.

630

PUMPELLE, R. et al.—Iron Ores of Missouri and Michigan. By Raphael Pumpelly, Late Director Geological Survey of Missouri; T. B. Brooks State Geologist Lake Superior Iron District; and Adolph Schmidt, Assistant in the Geological Survey of Missouri. With Illustrations in the Text, and Topographical and Geological Atlas. New York: G. P. Putnam's Sons. 1876. Part I, Geology of Pilot Knob and its Vicinity, by Raphael Pumpelly. Analyses of Iron-ores, Pig-irons, and Fuels, by Regis Chauvenet and A. A. Blair. Iron-ores of Missouri by Adolph Schmidt, Ph. D. Large 8°. 220 pp.

631

ROBINSON.—A Catalogue of American Minerals, with their localities: including all which are known to exist in the United States and British Provinces, &c. Boston. 1825.

This has 10 pages relating to Missouri minerals and localities.

632

ROEMER, F.—Ueber den Bau von Melonites multipora, ein Echinid des Amerikanischen Kohlenkalks. Von Dr. Ferd. Roemer, ord. Professor an der Universitat zu Breslau. 19 pp. <Archiv fur Naturgeschichte, von A. F. A. Wiegmann. Ein und zwanzigster Jahrgang. Erster Band. 1855. Pages 312-330. Taf. 1, figs. 1-6.

The specimen figured is a fine one from St. Louis.

633

SAMPSON, F. A.—Pettis county and Sedalia, Mo. Prepared by F. A. Sampson for the Immigration Committee of the Citizens' meetings. Sedalia, Mo. Press of H. Swalley. 1886. 16 pp. illustrations.

The geological and mineral account of the county is given on page 9.

634

SCHMIDT, A.—Ueber eine Umwandling des Hornsteins. By Dr. Adolf Schmidt. [Alterations of Hornstone.] Neues Jahrb. 1878. pp. 719-721.

Notices the hornstones of Southwest Missouri.

635

— Die Blei und Zink Erz-Lagerstaten von Missouri, von Adolf Schmidt. Heidelberg. 1876.*

636

SCHOOLCRAFT, H. R.—A View of the Lead Mines of Missouri: including some observations on the Mineralogy, Geology, Geography, Antiquities, Soil, Climate, Population and Productions of Missouri and Arkansas, and other sections of the Western Country. Accompanied by three engravings. By Henry R. Schoolcraft. 299 pp. Plates. New York. 1819.

637

— Scenes and Adventures in the Semi-Alpine Region of the Ozark Mountains of Missouri and Arkansas which were first traversed by De Soto, in 1541. Philadelphia, Lippincott, Grambo & Co. 1853. 256 pp.

638

SCHOOLCRAFT, H. R.—Journal of a Tour into the Interior of Missouri Arkansaw, and from Potosi, or Mine a Burton, in Missouri Territory, in a Southwest Direction, toward the Rocky Mountains: Performed in the years 1818 and 1819. London. 1821. 102. pp. Map.

639

SEAMON, W. H.—Tallow Clays. By Prof. W. H. Seamon. <Scientæ Baccalaureus, A Quarterly Journal of Scientific Research, Published under the auspices of the Missouri School of Mines. Vol. 1. No. 1, June, 1890, pp. 36–40. 4°.

640

SHEPARD, C. U.—Report of Prof. Charles U. Shepard, of Amherst College, Mass., in relation to Mineral Lands in the counties of Madison, Wayne and Iron, in the State of Missouri, belonging to Hiram N. Tong, of Ironton, Iron Co., Mo., made by him after an examination of the premises, May 17, 1860. St. Louis: Printed by M. Niedner, No. 43 Pine Street, near Third St. 1860. 15 pp. With map of the Ironton Mining Company Lands.

641

SHUMARD, B. F.—Report on the Chouteau League Tract, or Spanish Mineral Land Grant, known as United States Survey No. 2066, in Washington County, Mo.; made by Prof. Benj. F. Shumard, Assistant State Geologist of Missouri, 1864. Supplemented by report on the same tract, now the property of the St. Louis Lead Mining Company. By N. W. Bliss, General Superintendent of said Company, at their works, at Kingston Furnace, Washington County, Mo., Dec. 1, 1872. St. Louis: Democrat Lithographing and Printing Company. 1873. 29 pp. 2 folded plates, 1 folded map, 1 folded plat of the mineral lands.

642

— A Geological Report on the old Mines Property of William Long, Esq., in Washington County, Missouri. By B. F. Shumard, M. D. Saint Louis: B. P. Studley & Co., Printers, Binders and Lithographers. 1867. 20 pp.

643

— A Geological Report on the Enloe Mining Property of Allen P. Richardson, Esq., in Crawford County, Mo. By B. F. Shumard, M. D. St. Louis: Missouri Democrat Print, cor. Fourth and Pine Sts. 1867. 12 pp. Folded map.

644

SINGLETON, W. R.—Report on Ste. Genevieve, Iron Mountain and Pilot Knob Plank road. By Wm. R. Singleton, Principal Engineer. *

645

SOPWITH, T.—The Missouri Lead Mining and Smelting Company, Limited. Reports. London. Doherty & Co., Printers, 6 Great Newport street, St. Martin's Lane, W. C. 1879. 14 pp. 4°.

This has report on mines in Franklin County by Thomas Sopwith, Esq., Memb. Inst. C. E., and also report by J. B. Champion.

646

STRECKER, W.—Das Zink-Huettenwesen in den Vereinigten Staaten von Nord Amerika. Von W. Strecker. <Berghutt Jahrb. Bd. XXVII, pp. 282–353, pl. V.

The zinc deposits of DeSoto, Missouri, are noticed.

647

SWALLOW, G. C.—The Pacific Railroad Company offers at public sale * * * Farming, Timbered and Mineral lands. * * * St. Louis Mo. 1859. 57 pp.

The pamphlet has extensive reports by Prof. Swallow on the minerals of the counties traversed by the road.

648

— The Hannibal & St. Joseph Railroad Company have received by grant from Congress 600,000 acres of the choicest Farming and Wood lands, etc., etc. Hannibal, Mo., Hannibal & St. Joseph Railroad office. 1860. 12°, 60 pp. Maps and illustrations.

This has an account of the geology and soils of Northern Missouri, by Prof. Swallow.

649

—Report on the Mineral Lands of Messrs. Woods, Christy & Co., and Messrs. Christy & Woods, in Franklin County, Missouri, by G. C. Swallow, 1866. St. Louis. McKittrick & Co., Printers, cor. Main and Vine. pp. 49. Maps.

650

SWALLOW, G. C.—Prospectus of the Northumberland Lead Mining and Smelting Company. Location of Mines: near St. Clair, Franklin County, Mo. Main office of Company: St. Clair, Missouri. 4to. 16 pp., folded section and folded map of Franklin County, with the mines of the Company. [1880.]

This has a report on the mine by G. C. Swallow, made in Oct. 1865, when he was State Geologist; also various other reports.

651

— Report of G. C. Swallow to Directors of Carlton & Randolph R. R. 1859. 10 pp. 2 maps. (*)

652

— Letter of G. C. Swallow to W. M. McPherson, Pres. of the Pacific R. R., on Lands and Minerals of S. W. Mo. 8 pp. n. d., but prior to 1860. (*).

653

— Report of G. C. Swallow on North Missouri R. R. 1866. 12 pp. (*)

654

— Geology. [Geological Sketch of the State of Missouri.] By Hon. G. C. Swallow, A. M., M. D., Professor of Geology, Agriculture and Botany in the University of the State of Missouri, and late State Geologist. <Campbell's New Atlas of Missouri. St. Louis, 1873, folio, pp. 106–116, with section of the Rocks of Missouri, and Geological map of Missouri.

655

— Physical Geography of Missouri. By Prof. G. C. Swallow, M. D., LL. D. I—Topography; II—Geology; III—Mines and Useful Minerals; IV—Rivers and Springs; V—Prairies; VI—Timber; VII—Soils. 36 pp. <Campbell's Gazetteer of Missouri. 1874.

This has a Geological map of Missouri.

656

— Physical Geography. Geology, Mines, Minerals, Waters, Prairies, Timber and Soils of Missouri, by G. C. Swallow, LL.D. Former State Geologist, now Professor of Agriculture in the State University. 40 pp. <Switzler's History of Missouri, Part III. 1879.

657

SWALLOW, G. C.—Physical Geography of Missouri. Geology, etc. By G. C. Swallow, LL.D. <The Commonwealth of Missouri. A Centennial Record. Edited by O. B. Barnes. St. Louis. 1877; pp. 499–539.

658

TAYLOR.—Statistics of Coal. The Geographical and Geological Distribution of Mineral Combustibles or Fossil Coal, etc. Phil. 1848.

There is an account of the coals of Missouri on pages 169–171. The second edition, with additions by S. S. Haldeman, was issued in Philadelphia in 1855, and has a map with an account of the coals of Missouri on pages 484–487.

659

THOMPSON, R. O.—The Lead Deposits [of Missouri]. By R. O. Thompson, M. E. St. Louis. 15 pp. <Campbell's Gazetteer of Missouri. 1874.

660

— The Iron Deposits [of Missouri]. By R. O. Thompson, M. E. 10 pp. <Campbell's Gazetteer of Missouri. 1874.

661

THOMPSON, H. O.—Missouri Pottery Clays By Hugh O. Thompson, St. Louis. 3 pp. <Campbell's Gazetteer of Missouri. 1874.

662

VON GRODDECK, A.—Die Lehre von den Lagerstaetten der Erze. Ein Zweig der Geologie. Von Dr. Albrecht Von Groddeck, Bergrath und Director der Konigl. Preuss. Bergacademie und Bergschule in Clausthal. Mit 119 Abbildungen in Holzschnitt. Leipzig. Verlag von Veit & Comp. 1879.

This has accounts of the Iron Mountain on pages 145 and 267, and of the lead region on p 237 et seq.

663

VOGDEN.—Notes on the Distribution of Iron Ores in the United States, Compiled from various Geological Reports. Fort Monroe, Virginia. Printed at the United States Artillery School. 1886. Sq. 8°. 24 pp.

This has "Missouri. Geological position of the Iron Ores." 4 pp.

664

WALKER, C. B.—The Mississippi Valley, and Prehistoric events: giving an account of the original formation and early condition of the great valley; of its vegetable and animal life, of its first inhabitants, the mound builders, its mineral treasures and agricultural developments. All from authentic sources. By C. B. Walker. R. T. Root, Publisher, Burlington, Iowa. 1879. 539 pp.

There are several chapters on the geology and minerals of the valley.

665

WETMORE, A.—Catalogue of Minerals [in Missouri]. 5 pp. <Gazetteer of the State of Missouri. By Alphonso Wetmore. St. Louis. 1837.

There are also accounts of minerals, etc., in several counties of the State.

666

WHITNEY, J. D.—The Metallic Wealth of the United States, described and compared with that of other countries. By J. D. Whitney. Phil. 1854.

Accounts of the Missouri Copper ores, pp. 310-312; Lead, pp. 417-421; and Iron, pp. 478-481.

667

WILBER, C. D.—Mineral Wealth of Missouri. Two Lectures Delivered in the Hall of Representatives, at Jefferson City, Missouri, Feb. 17th and 18th, 1870. By Prof. C. D. Wilber, Instructor of Mining Lands. 5th Thousand. St. Louis, 1870. 67 pp.

These lectures were also published in the Agricultural Reports of Missouri.

668

WILSON, L. A.—Wilson's History and Directory for Southeast Missouri and Southern Illinois. * * * * * Compiled and Published by L. A. Wilson, Cape Girardeau, Mo. 1875-76.

This has a catalogue of the lead mines of that part of the State that were worked in 1818, as well as statistics of later date.

669

WILSON, J. N.—Lead and Zinc Ore of Southwest Mo. Mines. Authenticated Statistics. The Output of Lead and Zinc Ores from this Mining District for the year ending March 1st, 1887. By John N. Wilson, Carthage, Missouri, with contributions by F. L. Clerc and Thos. N. Davey. Printed at office of Jasper County Democrat, Carthage, Missouri. 32 pp.

670

WORTHEN, A. H.—Catalogue of American Paleozoic Fossils, the collection of Prof. A. H. Worthen, deceased, Late State Geologist of Illinois. Collected and purchased by him during fifty years of active life. Embracing 5,071 fine specimens, of which 752 are Types, and of these 240 are Crinoids, etc., etc. Warsaw, Illinois. 1889.

The catalogue contains 81 species of Missouri specimens, and of these 73 types.

671

WRIGHT, F.—The Ice Age in North America and its Bearings upon the Antiquity of man. By Frederick Wright. New York. 1889.

There are accounts of the glaciated area in Missouri on pp. 144, 213, 367 and on other pages.

MINERAL SPRINGS PUBLICATIONS.

These publications all contain analyses of the mineral waters.

672

BLUE LICK.—Blue Lick Springs, Saline County, Missouri. A Remarkable Group of Mineral Waters, Forming Nature's Own Sanitarium. Marshall, Mo. 32 pp. 5 ills.

This has an account of the coal, lead and other minerals of the county, taken from an article by Col. L. D. Burch, of Chicago, editor of the *American Sheep Breeder*.

673

EL DORADO.—El Dorado Springs, Cedar Co., Mo. Its History, Geography, Geology and the Therapeutics of its Waters. Sedalia, Mo. 12 mo. 30 pp. Small map. 4 ills.

The pamphlet is by Prof. P. Schweltzer of the State University. The analyses are by him, and also the account of the geology of Cedar County.

674

EL DORADO.—The Famous El Dorado Springs. The Great Health and Pleasure Resort of Southwest Missouri. Bazoo Print, Sedalia, Mo. 12 mo. 48 pp.

The analysis is by Prof. W. Wishon of the School of Mines at Rolla.

675

EXCELSIOR.—Excelsior Springs. A Description of the Marvels of a Pleasant Valley. * * * Issued by the Passenger Department of the Wabash Railroad. St. Louis, Mo. 1889. 22 pp. 8 ills. Small map.

676

PARIS CHALYBEATE.—Paris' Chalybeate Springs, Lawrence County, Mo. Health Resort. E. G. Paris, Proprietor. April, 1889, Springfield, Missouri, 12 pp., 16°.

677

PERTLE.—Pertle Springs, Warrensburg, Mo. Season of 1888. Their great advantages as a health and pleasure resort . . . By Incognito. Warrensburg, Mo. 1888. 24 pp. 12 mo. 3 ills.

The analysis is by Dr. C. M. Riley of St. Louis.

678

SWEET.—Sweet Springs, Saline County, Mo. . . St. Louis. 1882. 12 mo. 32 pp. 7 ills. Map.

This was issued by the Missouri Pacific Railroad. The analyses are by Dr. Charles P. Williams, Director of the Missouri School of Mines.

679

— Sweet Springs, Saline County, Mo. Season of 1886. D. W. Marmaduke, President. Leslie Marmaduke, Secretary. J. W. Hall, Lessee of Hotel. Sedalia. 12 mo. 32 pp. 14 ills. Map.

The analyses are the same as in the preceding. The edition of 1887 contains 36 pp.

680

— Summer & Winter Health & Pleasure Resorts. [Issued by the Missouri Pacific Railway Company, 1888.] 12°. 144 pp. Illustrations.

Under the head of Summer Resorts, pp. 35-53, the following mineral springs are described, analyses of the waters of most of them being given: Windsor Springs, near St. Louis; McAllister Springs, Saline county; Aurora Springs, Morgan county; Sweet Springs, Saline county; Blue Lick Springs, Saline county; Pertle Springs, Warrensburg, and El Dorado Springs, Cedar county.

COUNTY HISTORIES.

681

ANONYMOUS.—Geology, Physical Features, etc. [of Missouri.] pp. 12-39. Physical Description, Geology, etc., of Southeast Missouri. pp. 197-220. New Madrid Earthquake region. pp. 304-308. <History of Southeast Missouri, embracing an Historical Account of the Counties of Ste. Genevieve, St. Francois, Perry, Cape Girardeau, Bollinger, Madison, New Madrid, Pemiscot, Dunklin, Scott, Mississippi, Stoddard, Butler, Wayne and Iron, and including a department devoted to the preservation of personal, professional and private records. Illustrated. Chicago. The Goodspeed Publishing Co. 1888.

Quite interesting and full histories and descriptions of the mines in the counties named are given in the second article. It is said to have been written by a Mr. — Wheatley, who since died at Ft. Smith, Ark. The first article is also found in other volumes issued by the Goodspeed Publishing Co.

County histories issued by the same publishing company are: "History of Laclede, Camden, Dallas, Webster, &c. Counties. 1889." "History of Cole, Moniteau, &c. Counties. 1889." "History of Franklin, &c. Counties. 1888."

682

— Natural History, Geology, etc. (of Missouri). 12 pp. <History of Johnson County, Missouri. F. A. North. Chapter III, pp. 192-203. 1881.

683

— Geology and Minerals (of Missouri). 20 pp. <History of Pettis Co., Missouri. F. A. North. pp. 66-85. 1882.

684

— Geology of Missouri. 6 pp. <History of Jasper County, Missouri. F. A. North. Chapter II, pp. 18-23. 1883.

685

— Geology of Missouri. <History of Greene County, Missouri, written and compiled, &c. Illustrated. St. Louis: Western Historical Company. 1883. Chap. III, pp. 13-20.

686

ANONYMOUS.—Geology of Missouri. 8 pp. <History of Andrain County, Missouri. National Historical Company. Chapter III, pp. 13-21.

The same article is contained in other county histories issued by the same company, as "History of Callaway County. 1884." "History of Caldwell and Livingston Counties. 1886." "History of Howard and Cooper Counties. 1883."

687

— History of Cole, Moniteau, &c. Counties. The Goodspeed Publishing Co. 1889.

The geology of the counties is given as follows:

Cole, p. 204; Moniteau, p. 311; Morgan, pp. 394-401; Benton, pp. 453-459; Miller, pp. 527-528; Maries, pp. 584-586; Osage, 629-630.

688

— History of Laclede, Camden, etc., Counties. The Goodspeed Publishing Co. 1889.

The geology of the counties is given as follows:

Laclede, pp. 13-18; Pulaski, pp. 57-100; Webster, pp. 166-170; Camden, pp. 279-284; Wright, pp. 355-359; Texas, pp. 426-429; Dallas, pp. 493-496; Dent, pp. 564-566; Phelps, pp. 622-627.

689

— History of Franklin, Jefferson, etc., Counties. The Goodspeed publishing Co. 1888.

The geology and mineralogy of the counties are given as follows:

Franklin, pp. 206-214; Jefferson, pp. 364-369; Washington, pp. 459-461; Crawford, pp. 537-543.

690

— Physical and Geological Features. 7 pp. <History of Howard and Cooper Counties. Chap. XVI, pp. 320-326.

691

BROADHEAD, G. C.—Geology of Bates County. <History of Bates County. (*)

692

MATHEWS, D.—Natural History of the County, including its Topography; its Hydrography; its Geological Formations, etc. By D. Mathews. 12 pp. <History of Jasper County, Missouri. F. A. North. Chap. II, pp. 137-150. 1883.

693

SAMPSON, F. A.—The Natural History of the County, including its Geological Formations; its Paleontology; its Conchology; its Botany, etc., with Partial Lists of Distribution of Species. By F. A. Sampson. 19 pp. <History of Pettis County, Missouri. F. A. North. Chap. III, pages 221–239. 1882.

694

SWALLOW, G. C.—Geology of Greene county. By Geo. C. Swallow, LL.D. <History of Greene County, Missouri. Western Historical Company. 1883. Chapter XVII, pp. 573–575. Portrait of G. C. Swallow.

COUNTY ATLASES. FOLIO.

695

ANONYMOUS.—History of St. Francois County. <Historical Atlas of the World. Higgins Bro. & Co. Publishers. Chicago. 1882.

This gives large views of the St. Joe Lead Mines, the Desloge Lead Co. Mines, both at Bonne Terre, and the Syenite Granite Quarries at Syenite.

696

— Geology of Cooper Co., Mo. <Illustrated Atlas Map of Cooper County, Missouri. St. Louis Atlas Publishing Co. 1877.

697

— Geological Formation and Mineral Resources of Greene Co., Mo. <An illustrated Historical Atlas Map of Greene County, Mo. Brink, McDonough & Co. 1876.

APPENDIX.

The following titles were not obtained in time to be inserted in their proper order.

AGE OF STEEL, St. Louis.

(A partial list.)

698

EDITORIAL.—(Table showing the production of pig iron in Missouri from 1872 to 1884.) <Vol. LVII, No. 9, Feb. 28, 1885.

699

— Spelter and Lead. <Vol. LIX, No. 13, March 13, 1886.

Shows receipts and shipments of lead and zinc at St. Louis, and over what roads received.

700

THOMPSON, H. M.—Missouri Tin Mines. By Hugh M. Thompson. <Vol. LIX, No. 13, March 27, 1886.

701

— A Missouri Lead Mine. By Hugh M. Thompson. <Vol. LIX, No. 22, May 29, 1886.

An account of the St. Joe Lead Mine at Bonne Terre.

DE BOW'S REVIEW.

(A partial list.)

702

ANONYMOUS.—Lead Mining in Southern Missouri. (From the Western Journal.) <Vol. XVIII, O. S., March, 1855, pp. 389–391.

703

EDITORIAL.—Great Cities of the West—St. Louis. <Vol. XVI, O. S., April, 1854, pp. 397–410.

Notices the mineral regions within reach of St. Louis.

704

—The State of Missouri. Immigrants—Mineral Wealth—Coal, Soil, Productions, Public Lands, Tobacco, Hemp, Vineyards, Timber, Grasses, etc., etc. <Vol. 2, No. 5, Nov. 1866, pp. 481–489.

ENGINEERING AND MINING JOURNAL.

705

The first two volumes of this journal were published in 1866, and there have been two volumes each year since, so that the year of any volume can readily be found when not given. The titles from the first seven volumes, and a few of those from the succeeding volumes, up to the twenty-seventh, were copied at the office of publication in New York, and were not seen by the compiler.

706

ANONYMOUS.—Missouri's Rank as a Mining State. <Vol. 1, p. 42. 1866.

707

—Lead. <Vol. II, pp. 342, 374.

An account of a trip to Potosi, with a description of the geology of the lead fields.

708

—Missouri Iron and Indiana Coal. (Copied from *Mississippi Valley Review* of April 16, 1870.) <Vol. IX, pp. 276 and 291.

709

—Caves in the Ozark Mountains. Explorations by a party from St. Louis—a voyage up a subterranean river—a forest of stalactites. (Copied from the *St. Louis Republican*.) <Vol. X, p. 152.

710

—The New Cornwall in Missouri. (Copied from *United States Railroad and Mining Register*.) <Vol. X, pp. 298–299.

711

ANONYMOUS.—The Tin Mines of Missouri. (Communication signed "Missouri.") <Vol. XIII, p. 56.

712

— Zinc in Missouri. (Copied from *St. Louis Railway Gazette*.) <Vol. XVIII, pp. 37–38.

713

— The Zinc Mines in Dade County, Mo. (From *Mines, Metals and Arts*.) <Vol. XVIII, p. 371.

714

— Southwest Missouri lead interest—a proposed lead combination. (Correspondence signed B.) <Vol. XXV, p. 73.

715

— Missouri lead smelters. (Correspondence signed B.) <Vol. XXV, p. 91.

716

— Missouri Minerals. (Correspondence signed B.) <Vol. XXV, pp. 276–277.

717

— Old Granby Mines, Newton County, Missouri. (Correspondence signed B.) <Vol. XXV, p. 406.

718

— Silver in Missouri. (Special correspondence.) <Vol. XXV, pp. 310–311.

This is an account of the Einstein Silver Mines in Madison County.

719

— Missouri Mining News. (Special correspondence.) <Vol. XXV, pp. 311–312.

This also has an account of the Einstein Silver Mines.

720

— The lead interests of the Mississippi Valley. (Special correspondence.) <Vol. XXV, p. 55.

721

— Lead Phantom. (Special correspondence.) <Vol. XXVI, pp. 57, 93.

Has an estimate of the bulks of lead and zinc in mines and dumps.

722

ANONYMOUS.—Concentrating ores in Southwest Missouri. Written for the Engineering and Mining Journal. <Vol. XXXV, (1883), p. 207.

723

— Missouri steel to the Mahoning Valley; or, "Coals to Newcastle." (Special Correspondence, signed "Veritas.") <Vol. XL, (1885), p. 94.

724

— The mineral resources of Joplin, Mo. <Vol. XLIX, (1890), p. 286.
The history, geology and production of the Joplin mines are given.

725

BEAUREGARD, Hy. M.—Missouri Tin. By Hy. M. Beauregard. Correspondence, with comments. <Vol. VII, p. 277.

726

— Missouri Tin Assays. Correspondence. <Vol. IV, p. 407.

727

BERGEN, J. Y.—The construction and operation of Slag-hearths. By J. Y. Bergen, Jr. <Vol. XIX, pp. 269-271.
Shows the results as obtained in Missouri lead mines.

728

BROADHEAD, G. C.—The Southeast Missouri lead district. By G. C. Broadhead, Pleasant Hill, Mo. (Read before the Am. Inst. of Mining Engineers.) <Vol. XXII, pp. 59-60.

729

CLERC, F. L.—The mining and metallurgy of zinc in the United States. By F. L. Clerc. (From Mineral Resources of the United States. <Vol. XXXVI, (1883), pp. 148-151, 168-169 and 180-181.
"The Lead and Zinc Region of Southwest Missouri" is a part of the article.

730

— The Lewis-Bartlett process as applied at the Lone Elm works, at Joplin, Mo. Written for the Engineering and Mining Journal, by F. L. Clerc. <Vol. XL, (1885), pp. 4-6, 3 illustrations.

731

CLERC, F. L.—Mineral resources of Joplin, Mo. Communication from F. L. Clerc. <Vol. XLIX, (1890), p. 308.

732

ELLIOTT, R. S.—Iron in Missouri. Extract from address of R. S. Elliott before the members of the Legislature. Copied from Bulletin of the American Iron and Steel Association. <Vol. X, p. 120.

733

FLETCHER, F. H.—The Mineral Resources of Missouri. By Frank H. Fletcher. <Vol. I, p. 260; Vol. II, p. 261, 407; Vol. III, pp. 41, 48, 147, 190; Vol. IV, p. 2.

734

— The Thomas Mines. <Vol. III, p. 147.

735

GAGE, J. R.—On the Occurrence of the Lead Ores in Missouri. By James R. Gage, M. E. (Read before the Am. Inst. of Mining Engineers.) <Vol. XVIII, pp. 194 and 209-210, illustrated.

736

GENTH, F. A.—Tin Mines in the United States. By F. A. Genth. <Vol. IX, p. 322.

737

— Explanation of the discrepancy in assays of tin ores in Missouri. <Vol. X, p. 378.

738

GOULDING, T. R.—Treatment of Tin Ores in Missouri. Their Value—Assays. By T. R. Goulding. <Vol. IV, p. 329.

739

HEWITT, A. S.—A Century of Mining and Metallurgy in the United States. Centennial Address of Hon. Abram S. Hewitt, President elect of the American Institute of Mining Engineers, Philadelphia, June 20, 1876. <Vol. XX, pp. 609-615.

740

JULIEN, A. A.—The origin of crystalline iron ores. (Abstract of Dr. Alexis A. Julien's paper before the New York Academy of Sciences.) <Vol. XXXV, (1883), p. 207-8.

The Huronian hematites of Lake Superior and Missouri are described.

741

KROM, S. R.—St. Joseph Lead Company's Dressing Works at Bonne Terre. Communication from S. R. Krom, New York. <Vol. XLVIII, (1889) p. 3.

This is a criticism of some points in the paper of Prof. Munroe in the preceding volume.

742

MERRILL, W. E.—Report on Missouri Tin Ores, by Col. W. E. Merrill, U. S. Army. <Vol. IV, p. 373.

743

Mining and Mineral items.

Vol. I—

Missouri lead. In Vol. I, pp. 185, 201, 218, 234, 250, 279, 295, 327, 343, 359, 394, 410.

Coal in Missouri, p. 54.

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Copper fields in Missouri, p. 307.

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Coal measures of the Southwest, p. 405.

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Missouri Zinc Manufacture, Editorial, p. 25.
Missouri tin mines, Editorial, p. 228.
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Remarkable lead deposit, pp. 235-236.

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Vol. XVIII—

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Granby Lead mines, p. 19.
Notice of *Southwest Missouri Mines*, p. 106.
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Schmidt's report on iron ores, p. 324.

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The Silver mine at Silver Mountain, Missouri, p. 149.

The Silver Mountain Mining Company mine, p. 204.

The Missouri Zinc mines, p. 475-6.

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Lead mine near Jerico, p. 203.

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Granby lead mines, p. 94.

Joplin lead mines, p. 110.

Granby Mining and Smelting Company, p. 199.

Vol. XXXIX—

Lone Elm works, Joplin, Mo., p. 180.

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Production of iron ore in Missouri in 1883, 1884, p. 419.

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Desloge Lead Mining Company, p. 48.

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- Oil at Kansas City and Zinc at Carthage, p. 191.
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- Morgan County coal, p. 30.
- Iron Mountain Company, p. 71.
- The Burch Lead and Zinc Mining Co. p. 378.
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- Jasper County Lead and Zinc Mines, pp. 33, 67, 91, 92, 116, 143, 183, 207, 233, 257, 318-319, 367, 430, 478-479, 544-545, 571, 595, 648, 687, 713 and 740.
 - Newton County Mines, p. 143.
 - The Lehigh District and Bates County, p. 183.
 - Mine-a-Joe, St. Francois Co., p. 233.
 - Bulletin No. 1, Geology Survey of Missouri, p. 558.
 - Gentry county coal, p. 622.
- Vol. L—
- Jasper County Lead and Zinc Mines, pp. 55, 82, 108, 134-135, 174, 226-227, 253, 278, 318, 344 and 370.
 - Newton county lead, p. 344.

MOBBILL.—Analyses of tin ores in Missouri and California. By Col. Morrill. <Vol. V, p. 151.

745

MUNROE, H. S.—The new dressing-works of the St. Joseph Lead Company, at Bonne Terre, Missouri. Paper read by Prof. H. S. Munroe, before the American Institute of Mining Engineers. <Vol. XLVII, (1889), pp. 566-569, and pp. 588-592. Many illustrations.

746

NEILL, J. W.—Treatment of nickel-cobalt mattes at Mine LaMotte, Missouri. By James W. Neill, E. M. (Read before the American Institute of Mining Engineers, February, 1885.) <Vol. XXXIX, (1885), pp. 108-109.

747

NEWBERRY, J. S.—The origin and classification of ore-deposits. By Prof. J. S. Newberry. <Vol. XXIX, pages 421-422 and 437-438.

The lead deposits of Missouri, both in the southeast and in the southwest, are given as typical examples of the occurrence of mineral in *gash veins*.

748

— The genesis of our iron ores. By Prof. J. S. Newberry. <Vol. XXXI, (1881), pp. 286-7 and 298-300.

The iron ores of Missouri are considered to be Huronian, and of the same age as those of Lake Superior.

749

PACK, J. W.—Process of Spelter Production, as Practiced at Carondelet, Missouri, with Comparisons. By Jno. W. Pack. (Read before the Am. Inst. Mining Engineers.) <Vol. XVIII, pp. 226 and 242.

750

POTTER.—Local Coal Deposits in Missouri. Editorial. <Vol. XVII, pp. 289 and 305, ills.

751

PUMPELLY, R.—(The Iron Ores of Missouri. Remarks by Prof. R. Pumpelly before the Am. Inst. of Mining Engineers.) <Vol. XXII, p. 1.

752

RAYMOND, R. W.—American Lead Mines. Editorial. (Rossiter W. Raymond.) <Vol. X, p. 105.

753

— The Missouri Tin Question again. Editorial. <Vol. X, p. 378.

Includes a letter from F. A. Geath to *U. S. Railroad and Mining Register* of Philadelphia.

754

RAYMOND, R. W.—Missouri Tin. Editorial. <Vol. XIII, p. 137.

755

— Peculiar Iron Ore Deposits in Missouri. Editorial. <Vol. XVII, p. 209. Illustrated.

756

— Notice of Pumpelly's Geological Survey of Missouri. <Vol. XVII, pp. 136-137 and 153-154.

757

— Iron Ore Production of Missouri. Editorial. <Vol. XVIII, p. 387.

758

— Missouri Iron Ores. Editorial. <Vol. XVIII, p. 324.

759

— On a geological map of the United States. (Read before the American Institute of Mining Engineers.) <Vol. XVI, pp. 322-324.

760

— Missouri zinc ores. Editorial. (Rossiter W. Raymond.) <Vol. XXVIII, (1879,) page 123.

761

— Note on the zinc deposits of Southern Missouri. By Rossiter W. Raymond, Ph.D. <Vol. XXVIII, pp. 240-241.

762

— The classification of ore-deposits—Prof. Newberry's paper. Editorial. (Rossiter W. Raymond.) <Vol. XXX, pp. 1-2.

This is a criticism in part on the theory of gash-veins of Prof. Newberry, as found in the Mississippi Valley.

763

— The St Louis Meeting of the Institute. Editorial. (Rossiter W. Raymond.) <Vol. XLII, (1886), p. 308.

The Institute of Mining Engineers held its meeting in St. Louis, and the members visited the St. Joe Lead Mines, Pilot Knob Iron Mines and Crystal City Glass works, and this is an account of these places.

764

ROBINSON.—Oil boring in Missouri. Correspondence. <Vol. IV, p. 297; Vol. V, p. 261.

765

ROESSLER, A. W.—Examination of Missouri tin. By A. W. Roessler. < Vol. V, p. 313. 1868.

766

— Missouri Lead and Coal. Note about the Simpson Mines in Monticau County. <Vol. VII, p. 276. 1869.

767

— Report of the geologist of the General Land Office. <Vol. XI, pp. 59–60.

Notices the tin ores in Missouri.

768

— The Ores of the West. <Vol. VIII, p. 407.

769

ROTHWELL, R. P.—The lead and zinc ores of Southwest Missouri. Editorial. (Richard P. Rothwell.) <Vol. XLIII, (1887), pp. 397–398.

This is an account of the lead and zinc region as given in a pamphlet giving statistics of production for 1887. (No. 669 of this Bibliography.)

770

— The roll of ignorance in mine explosions. Editorial. (Richard P. Rothwell.) <Vol. XLVI, (1888), pp. 79–80.

This is in regard to the Rich Hill coal mine explosion.

771

— The St. Joseph Lead Company. Editorial. (Richard P. Rothwell.) <Vol. XLIX, (1890), p. 103.

772

— Mine owners and engineers of Joplin, Jasper County, Mo. Editorial. Illustrated. <Vol. L, (1890), pp. 96–97.

773

SMOCK, J. C.—Geologico-geographical distribution of the iron ores of the eastern United States. By John C. Smock, New Brunswick, N. J. <Vol. XXXVII, (1884), pp. 217-218 and 230-232.

The Iron Mountain and Pilot Knob districts are described, and the ore stated to be of the Huronian period.

(This paper was read before the American Institute of Mining Engineers.)

774

STEVENS, C. W.—The artesian well 3235 ft. deep. Letter of Chas. W. Stevens, with comments. <Vol. VI, p. 133.

775

STOPFF, F.—The Iron Mines of Pilot Knob, Missouri. By Dr. F. Stopff, St. Louis, Mo. <Vol. IX, pp. 259-261.

776

— American Mining and Metallurgy from a foreign standpoint. Notes of a tour of observation. By Prof. F. Stopff, Sweden. <Vol. IX, pp. 34-35, 50-51, 66-67, 129-130, 146, 186.

777

TYLER, S. W.—Lead Smelting in Missouri. By S. W. Tyler, Engineer. <Vol. VIII, p. 114.

778

WILLIAMS, C. P.—Some Points in the Treatment of Lead Ores in Missouri. By C. P. Williams, Ph. D. (Read before the Am. Inst. Mining Engineers. <Vol. XXII, pp. 200-201 and 220-221.

779

— Notes on the Method of Preparation of Zinc Oxide. <Vol. XXII, pp. 361-362.

780

— On the Specific Gravity of Certain Leads in Missouri. (Read before the Am. Inst. Mining Engineers.) <Vol. XXIII, p. 238-239.

781

WINSLOW, A.—Report of the State Geologist of Missouri (for the month of May, 1890). By Arthur Winslow, State Geologist of Missouri. <Vol. XLIX, (1890), p. 683.

TRANSACTIONS OF THE MISSOURI STATE HORTICULTURAL SOCIETY.

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ERRATA

- No. 47—For House Journal read Senate Journal, and add, in House Journal, Appendix, pp. 180-192.
- 57—For 24th read Adjourned Session, 23d Gen. Ass'y, 1866.
- 102—For 1885 read 1883.
- 114—To "Eighteenth Report" add 1884.
- 165—For F. A. Clerk read F. L. Clerk.
- 241—For Vol. XVI read Vol. XVII.
- 245—The date given is of the meeting. The publication was 1889.
- 310—For Vol. XLII read XLIII.
- 326—The date of publication was 1882.
- 357—Add date 1862.
- 362—Add date 1890.
- 363—Add date 1882.
- 364—Add date 1883.
- 365—For *magnificus*, in line next to the last on page 82, read *magnificus*.
- 367—The date of publication was 1887.
- 403—For F. A. Clerk read F. L. Clerk [F. L. Clero].
- 462—In the blank after Vol. read IV.
- 490—In the third line from bottom of page 104, read *P. Copoerensis*.
- 573—For "Bauman" read "Bannan."
- 661—For Hugh O. Thompson read Hugh M. Thompson.

The first fifty volumes of the American Journal of Science are referred to simply by the number of the volume. Later volumes give the series, as well as the volume. The first fifty volumes are sometimes referred to as First Series. The second fifty were published as the Second Series. The succeeding volumes are the Third Series.

GEOLOGICAL SURVEY OF MISSOURI.

ARTHUR WINSLOW, STATE GEOLOGIST.

BULLETIN No. 3.

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NOTICE: The Bulletins of the Geological Survey are issued for the purpose of making public as quickly as possible statistical and other matter which is largely of temporary value, together with such other results of the work as can be briefly presented in a servicable form, in advance of the final reports. They do not embody complete results nor final conclusions. They are essentially provisional publications.

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THE CLAY, STONE,
LIME AND SAND INDUSTRIES

OF

ST. LOUIS CITY AND COUNTY.

By G. E. LADD, assistant geologist.

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PREFATORY REMARKS.

The field work for this report on the clays and structural materials of St. Louis was completed during the past summer. The preparation and publication of the results have, however, been delayed through successive interruptions caused by sickness and by the demands of a field season.

Special attention, it will be noticed, has been given to the statistics of the production, and truly surprising results have been reached. Within the area discussed the value of the respective products during the year 1889 is as follows: —

Structural brick.....	\$2,288,795 00
Fire clays, sewer pipes and pottery.....	1,722,685 00
Stone.....	665,761 00
Lime.....	103,000 00
Sand and gravel.....	76,229 00
Total.....	\$4,856,470 00

The principal object in obtaining these statistics was to demonstrate the magnitude of the industries dependent upon the natural products, which are Mr. Ladd's special subjects of work. The importance of the State of Missouri as a clay producer is recognized in a general way, yet there are no figures available by which that importance can be meas-

ured, nor is any adequate provision made by State or National government for the gathering of such figures. Nearly five millions of dollars seems a large sum to represent the production of St. Louis city and county alone; but this is undoubtedly far in excess of the value of the product from any other equal area in the State. St. Louis is not only the largest center of population, but it has also an exceptional supply of the raw materials, and is hence a large manufacturing center. Yet, though no one other place, and probably no three other places in the State combined, yield so great a product as does St. Louis, there is little doubt but that the product of these materials in the whole State is worth several times five millions.

Similarly with regard to the qualities of Missouri's clays. They have a high reputation and the refractory clays have been marketed in many States. But this reputation has been acquired through the use of clays handled by two or three firms which draw their supply from a very limited number of localities. Concerning the clay deposits of the State as a whole, and the qualities of the materials, little or nothing is known. Hence, among the considerations leading to an investigation of the St. Louis clays, an important one was the fact that a determination of the composition and an experimental test of the properties of some of these familiar clays would furnish an excellent local standard by which to measure the properties of clays occurring elsewhere in the State which are only partially or not at all developed. Such analyses and tests of these as well as of other clays of the State are now being carried on, but the results are reserved for the final report on the clays of the State, in which will be made a full exposition of the results.

ARTHUR WINSLOW,
State geologist.

INTRODUCTION.

This paper is a partial result of work done by the author during the past spring and summer in St. Louis and vicinity, in pursuance of the investigation of the clays and building stones of Missouri.

The materials discussed are of much importance to a great city, where, if they exist, they are sure to be extensively developed. With most of the ordinary structural materials needed by a city, St. Louis is, happily, well provided, and in the following pages the writer attempts to convey a fair impression of the nature and extent of the industries in the city and county which produce these materials; and also of the nature and extent of their sources of supply.

Objects of maps.

The sketch maps used have two purposes. One of these is to show in a rough way the distribution of the different geological formations, to which, in the text, the different kinds or grades of structural materials are referred. The other purpose is to show the location of all quarries, clay mines, brick and other works.

Two conventional sections are printed to show the reader at a glance the probable thickness, and the relative positions of the different geological formations.

Assistance.

A great part of the credit for whatever of value this paper may have is due to those who have lent their assistance to the author. Especially is he indebted to Mr. Elston H. Lonsdale for efficient aid in the field; to Mr. Amos E. Woodward for the analysis of many samples of limestone and clay, and to Mr. Leo Gluck for the drawing of maps and sections. A personal debt is also due Mr. J. D. Robertson and Prof. H. A. Wheeler for either valuable suggestions or aid in the field.

The report of Mr. B. F. Shumard on the Geology of St. Louis county, in 1855, has been an invaluable aid. The map showing the distribution of formations is mainly from Mr. Shumard's map, modified so much as the hurried observations of the author would warrant.

A LIST OF CLAY WORKS AND STONE QUARRIES IN ST. LOUIS CITY.

The locations of these quarries and works on the City Map are indicated by
their respective coördinates.

SEWER PIPE, FIRE CLAY AND TERRA COTTA WORKS.

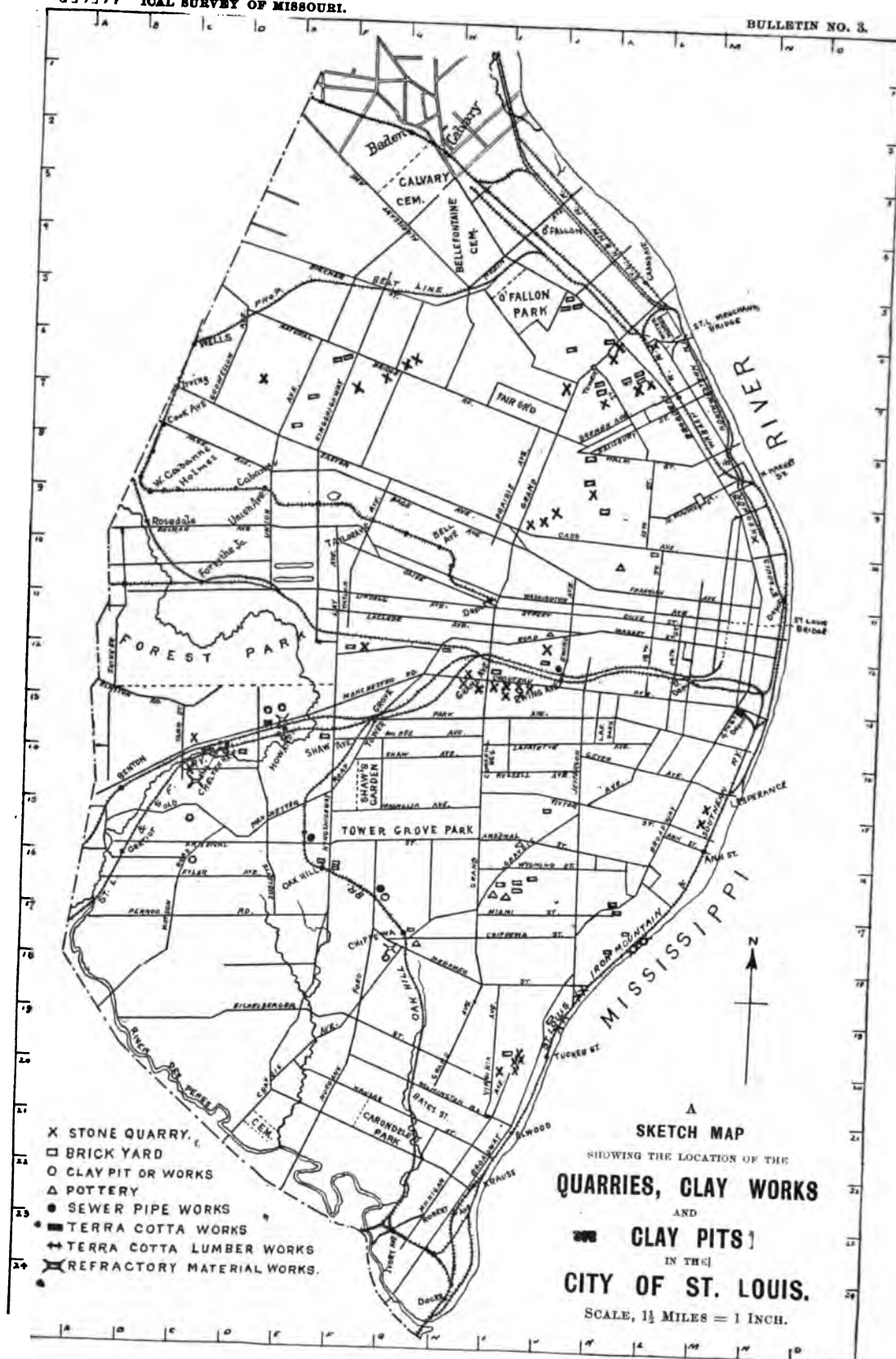
PROPRIETOR.	COÖRDINATES.	PROPRIETOR.	COÖRDINATES.
Blackmer & Post.....	E, 16 & J, 12	Mo. Fire Brick & Clay Co..	D, 14
Christy Fire Clay Co	G, 18	Mo. Terra Cotta Lumber Co	D, 14
Coffin, Thos. & Co.....	L, 6 & C, 15	Parker & Russell M. & M. Co	G, 17
Evans & Howard.....	E, 14	Towle & Thorpe.....	C, 16
Jones, David.....	D, 13	Winkle Terra Cotta Co....	D, 14
Laclede Fire Brick Mfg. Co.	D, 14	Wrisberg Mining Co.....	E, 18
Mitchell Clay Mfg. Co.....	E, 14		

POTTERIES.

PROPRIETOR.	COÖRDINATES.	PROPRIETOR.	COÖRDINATES.
Gnauk, Louis.....	G, 18	Seeber, August.....	I, 17
Muttig, Jno.....	J, 12	Uhlemeyer, August.....	I, 17
Schwarzkopf, Chas.....	I, 16	Wash Street Pottery.....	K, 10

STRUCTURAL BRICK WORKS.

PROPRIETOR.	COÖRDINATES.	PROPRIETOR.	COÖRDINATES.
Ballmann, Aug.....	L, 10	Lyon Press Brick Co.....	K, 17
Bergsicker & Bro	K, 7	Missouri Press Brick Co...	K, 18
Branahl, Chas.....	E, 7	Nieman, Aug. H.....	J, 17
Buckwinkle, Frank.....	J, 6	Oehler, Paul.....	K, 17
College Hill Press Brick Works	J, 5	Pahl, Henry.....	F, 17
Compton Av. Brick Works.	J, 12	Repping, J. H. & Son.....	J, 16
Eureka Press Brick Co.....	L, 7	Scales, Thos. H	K, 8
Excelsior Brick Co.....	K, 9	Schlingman, E.....	L, 7
Grote & Hilkerbaume.....	K, 7	Schlingman, Henry.....	L, 7
Hurman, Frank.....	E, 8	Schweer & Maes.....	J, 19
Hydraulic Press Brick Co., I, 18; H, 18; F, 16; D, 14; F, 14; H, 12		Smith, T. S.....	K, 6
Ittner, Anthony	J, 15	Sprengemann, Edward.....	I, 20
Kuehn, August.....	J, 5	Steinkamper, F. W	J, 9 & F, 7
Kulage & Menke.....	J, 5	Stuckenberg, Jno.....	J, 17
Kuntz, Chas.....	L, 17	Tower Grove Brick Works.	E, 17
Kuntz, Fritz.....	I, 17	Union Press Brick Co.....	F, 7
		Walkenhorst, F. W.....	F, 13



STONE QUARRIES.

PROPRIETOR.	COORDINATES.	PROPRIETOR.	COORDINATES.
Albernacius, Frank.....	L, 17	Kern, Adam.....	L, 17
Allen, E.....	J, 19	Kinealy & Sons.....	K, 7
Baldwin, Henry.....	I, 20	Knaus & Willis.....	J, 19
Bambrick-Bates.....	N, 9 (2)	Krug & Zesch.....	I, 20
Barnett, Wm. H.....	J, 12	Lohrum, Jno. C.....	L, 17
Brocksmith, H.....	C, 14	Lorentz, Martin.....	L, 17
Byrnes, Thos.....	J, 10	Mohun, Patrick.....	I, 13
Cavanaugh, T. E.....	J, 10	O'Meara, J. B....	F, 17; F, 12; K, 9
Devereux & Sons.....	G, 7	Perkinson, J. E. & Bro....	J, 7 & K, 6
Engleman, A. O.....	M, 15	Pickel, Conrad.....	I, 13
Eyerma, G. (Estate).....	I, 20 & I, 13	Pleper, Christian.....	I, 13
Friederichs, J.....	I, 20	Prendergast, G. E.....	D, 7
Fruin-Bambrick & Co.....	I, 13; H, 12; C, 14	Redemeyer.....	L, 7
Grund, Louis.....	K, 19	Stiefel & Ruckert.....	G, 6 & M, 15
Heman Bros.....	C, 10	"St. Louis Stone Masons"	I, 13
Hogan, E. W.....	K, 6	Watson Construction Co....	H, 13
Hogan, M.....	L, 7	Wieman, William.....	G, 6
Hogan & Moran.....	J, 9	"Work House".....	K, 19
Kempf, Conrad.....	I, 20		

A LIST OF THE STONE QUARRIES AND CLAY AND LIME WORKS IN ST. LOUIS COUNTY.

The locations of these quarries and works on the County Map are indicated
by the numbers in the columns.

PROPRIETOR.	STONE QUARRIES.	MAP NUMBER.
Andrew, —		68
Boem, Fritz		50
Bessen & Sons		64
Crystal Spring Quarry and Lime Co.		47
Doering, J. H.		51
Dore & Wallace		67
Eureka Quarry Co.		57
Exner, John		63
Fabrick, P. & Marshall		58
Glendale Quarry Co.		55
Jefferson Barracks		68
Lauritzen, Jas		56
Madden, Thos		58
Munsen, —		52
Pope, Andrew		59
Schwenn, John		66
Selfert, Henry		60
Shore's Quarry Co.		54
Steffen, John C.		61
Theby, Michael		48
Watson Construction Co.		65
Zeiss, Henry & Mrs		49

PROPRIETOR.	CLAY WORKS.	MAP NUMBER.
Jameson, William		124

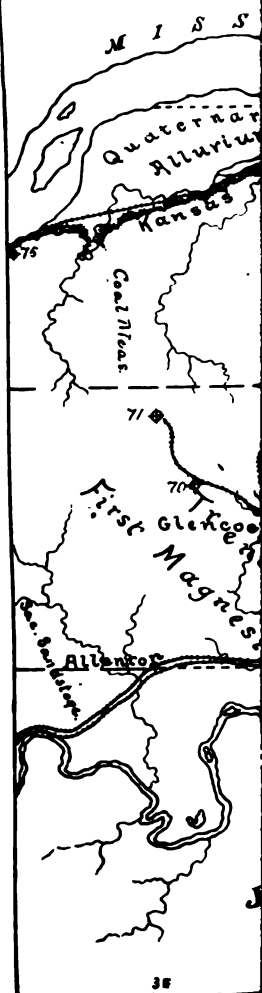
PROPRIETOR.	LIME WORKS.	MAP NUMBER.
Dorenheim, Herbert		76
Glencoe Lime & Cement Co.		70 to 72
Goetz, Chas. W.		73 and 75
Thorn & Hunkins		74

ST. L.
SHO
QUARRIES, C
AND
GEOLO

REPROD
MO

Scale, 4 miles = 1

- x STONE QUARRIES
- ◆ LIME WORKS
- CLAY PIT OR





GENERAL GEOLOGY.

St. Louis city and county are bounded on the north by the Missouri river, on the east by the Mississippi river, on the south by the Meramec river and a part of Jefferson county, and on the west by Franklin county. Boundaries of the area.

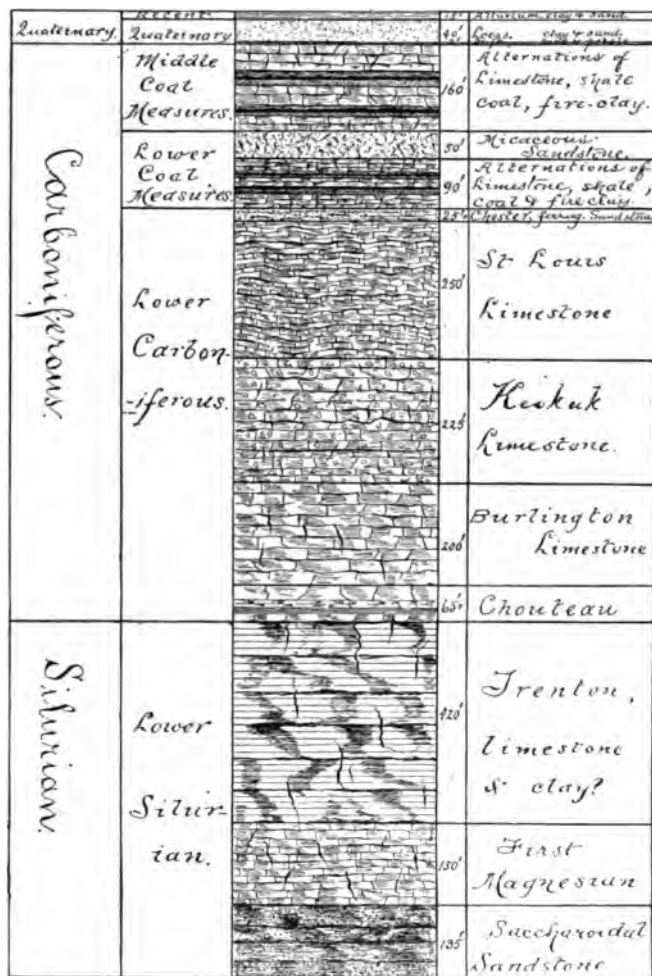
The geology of this area was described in a general way by B. F. Shumard, during the Swallow survey, in 1854. No detailed study has followed his work, and, in the absence of such a study, the writer has adopted, for the purpose of reference in this paper, Mr. Shumard's determinations of horizons. Determination of horizons. With reference to the distribution and extent of some of the formations, modifications have, however, been made.

A section of most of the local formations was constructed by Professor G. C. Broadhead, in 1875, from the borings and accompanying records of the St. Louis Insane Asylum well, which was sunk to a depth of nearly four thousand feet. The section. This section does not include the Middle Coal Measures nor the Ferruginous Sandstone of the Chester Group. It includes, however, many of the older rocks which do not reach the surface in either the city or county.

The formations are all of sedimentary origin. They represent a wide range of time and a considerable variety of conditions of deposition. They have nearly all been somewhat disturbed from their original positions.

On the accompanying map their distribution is provisionally shown. The Quarternary deposits, which are not outlined as a whole, cover nearly the entire area.

GENERAL GEOLOGICAL SECTION OF THE FORMATIONS IN ST. LOUIS CITY AND COUNTY.

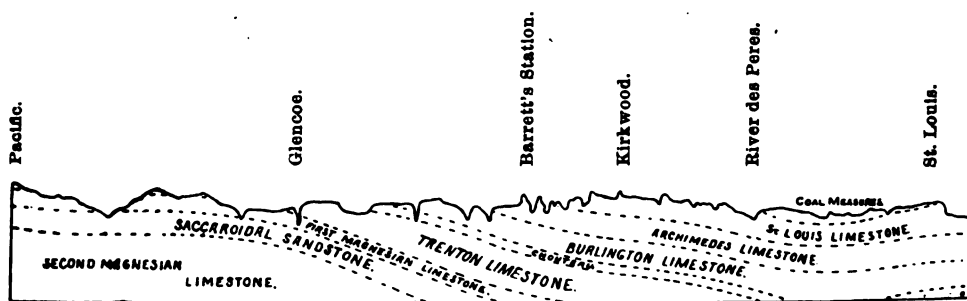


Some of these figures are estimated, others are taken from the record of the Insane Asylum well.

This general section is compiled from Shumard's and Broadhead's publications, and the author's observations. It includes only such formations as reach the surface within the described area. By reference to this section it will be seen that three grand divisions of time have been recognized here, viz., the

Quaternary, Carboniferous and Silurian. Between and within these divisions great thicknesses of formations belonging to the general section of the State are without representation. There is a clear gap in the section, from the Quaternary deposits to the Middle Coal Measures, a second from the Chouteau to the Trenton Limestone, and a third from the Trenton to the first Magnesian Limestone. The gap in the section.

The disturbances which are referred to above are manifested in the formations below the Coal Measures by a distinct dip in a northeasterly direction, gentle undulations, rather sharp anticlinal and synclinal folds, and occasional faults. Disturbances. The Coal Measures have been slightly flexed. The Quaternary deposits are undisturbed, save by erosive influences.



GENERAL CROSS SECTION THROUGH ST. LOUIS COUNTY, MODIFIED FROM SHUMARD'S.
Looking north.

The diagrammatic cross section, above, shows approximately the relative positions of the various formations. It runs from the northern part of St. Louis, in a direction a little south of west, to a point near Pacific.

Topographic sheets of most of the area discussed in this paper have been already completed by the United States Geological Survey, and they will form the basis for detailed geological work in the future. Of much importance here are the questions of distribution, of relative position, and of the characteristics of the materials. The great industries which have arisen to handle these materials owe their origin largely to some accident of discovery, and they have grown in spite of the burden of much costly experiment. They have lacked always a local standard to which to refer their products, a working knowledge of the extent of their deposits and of their persistence in character.

THE CLAY INDUSTRY.

GENERAL REMARKS.

Sources of clay. Geologically speaking, St. Louis has three local sources of clay. These are the Coal Measures, the Quarternary deposits, and the residuary product of decomposing limestones.

THE COAL MEASURE CLAYS.

Distribution. The Coal Measures* which have an area approximating two hundred square miles in St. Louis county, and city, carry practically an inexhaustible supply of potter's, sewer pipe, and fire clays, of which the best of the latter have been long famous for their high refractory qualities. The mining and manufacturing of these clays has been carried on for many years, and to a large extent, in the immediate neighborhood of St. Louis, but so far as the writer knows, there has been no worthy attempt to even prospect for them in the great stretch of Coal Measure formation in the northwestern part of the county.

Conditions of occurrence and character of the clay. *Tile Clays:*—The clay which is used largely for the production of sewer pipes, though low down in the Coal Measure series, is one of the uppermost layers in that portion of the formation which occurs along the western border of St. Louis. This tile clay bed overlies the fire clay bed described below and is separated from it by shale and sandstone six to twenty or more feet thick. It is usually covered with several feet of Loess clays, and is occasionally capped with beds of decaying limestone, which were not altogether denuded from above it before the Loess clays were deposited. It ranges in thickness from about eight to twelve or more feet. Its color varies, but is usually mottled red and brown, with bluish and greenish streaks. It is fissile, is quite free from grit, and has a soapy feel to the fingers. It is sometimes hard and shaly, but is usually soft when mined; growing hard on drying, after being exposed to

* See sections on pages 21, 22, 23 and 25.

the air. Crystals and thin coatings of gypsum, and nodules of limonite are scattered through the bed. The clay when used for sewer pipes is mixed in varying proportions with fire and other clays. Wherever produced at present it is dug in open pits.

Fire Clays: — The fire clays occur in beds ranging from a few inches to seven or more feet in thickness. They are occasionally so near the surface as to be mined by drifts, but usually they have to be sought by shafts. The deepest of these in St. Louis (that of Parker & Russell), is one hundred and twenty feet from the surface of the ground to the bottom of the clay bed.

Conditions of
occurrence.

These clays, even in the same bed, vary largely in character and composition. They are usually grayish in color, and are very hard when mined, but after exposure to the weather for a variable time the clay softens or slacks and falls into a loose mass of finely divided particles. Iron, an objectionable material in a fire clay, occurs largely in small pyrites crystals, called by the clay miners "shiners" and sometimes in large balls of pyrites. These "shiners" occur generally in aggregations, and either close to the top or bottom of the clay bed, so that they may be avoided to a great extent in mining. The best grades of clay, those suitable for making glass house pots in a raw and unwashed condition, are of limited occurrence and they are not continuous in the bed in which they are found; they may be considered as existing in "pockets," though there is no sharp line of demarkation of the deposit, but the transition from the best clay into the poorer grades is gradual. The only fossils found in the St. Louis fire clays are stigmata, and calamites, fine specimens of which were obtained from the top of the bed at the mine of William Wrisberg and the adjoining one of Daniel Jones.

Character of the
clay.

Pot clays.

Stigmata.

The fire clay is mined in chambers which are kept well timbered until they have been carried as far as possible, when the timbers are removed, and the roof is allowed to drop in, the debris forming a wall for a new chamber which will be run along the side of the old one. There are probably several miles of these chambers within the city of St. Louis. Immediately overlying the clay is generally either a hard shale or a bed of sand-

Method of mining.

stone, which makes a very good roof. At some of the mines a bed of coal lies just above the fire clay, but it rapidly thins out and almost quite disappears at other mines. The clay is so hard that it is necessary to use powder to dislodge it from its bed.

Value of clays. The fire clays sell in the market for from one dollar or less to about fourteen dollars per ton, according to their purity. Most of the clay sold for glass house pots has undergone a process of washing, for the purpose of removing iron and objectionable alkalies, and of giving uniform character to different shipments. Before being made into refractory materials it is exposed to the action of the weather, often for several years.

THE QUARTERNARY CLAYS.

Distribution. The Quarternary deposits cover as a mantle nearly the whole area of the older formations in the city and county, and the great mass of the Quarternary is of the Bluff or Loess formation which is composed essentially of clay, and occasionally of sand.

Uses of Quarternary clays. This Loess is what is known as yellow clay, or common brick clay, and its supply for such brick baking, for which purpose it is well adapted, is inexhaustible, although it is being rapidly removed within the city limits. Bricks are made from it by both a dry and a wet process, but most largely by the dry one. The clay is plowed up, on a fair day, to the depth of a few inches, and, after several hours drying in the sun, it is scooped together and hauled to sheds, where it is stored for future use. It is usually of the proper composition for brick making throughout, without special mixing; but, in places, it is too sandy near the bottom.

THE RESIDUAL CLAYS.

Clays, residual from limestone, occur beneath the Loess or Drift. They are too plastic to be used alone, but are occasionally used by potters, mixed with other clays.

A DESCRIPTIVE LIST OF THE CLAY WORKS.

This list includes all of the miners of clay and manufacturers of clay products, who were found by the writer to handle the clays which occur within the area discussed in this paper. The descriptions are intended to include such obtainable matter as might have a general value for purposes of reference. Many de- Scope of list. tails are omitted here, which are to be presented later in a more specific report on the clays, and the methods of manufacturing products from them. Following this list are statistical tables which give such additional information as could be conveniently classified and presented in tabular form, and which demands immediate publication.

By glancing at the accompanying maps it will be seen that the producers of sewer pipes and clay refractory materials are mainly located where railroad facilities for shipping their product could be had, and that they are also thickly grouped in the vicinity of the Cheltenham works, in the southwestern border of the Distribution of works. Coal Measure formation. This latter fact is probably due, in a great measure, to the reputation of these Cheltenham clays, and not to the fact that equally good clays are wanting in other parts of the city, and in the county. The maps show no particular grouping for other clay works, for their markets are mostly local and the clays used are so widely distributed, easily tested, and easily obtained, that their situation is mostly due to accidental conditions.

THE PRODUCERS OF FIRE BRICK, FIRE CLAY AND SEWER PIPE.

The industry to which these producers belong is one for which St. Louis has long been famous, particularly with regard to the Cheltenham fire clays. It is an industry which is constantly expanding; new factories are being built and old works Character of plant. are being enlarged and improved. Some of the works are magnificently equipped. They have fine clay beds almost touching their splendid factories, and railroad lines pass close

by or through their yards. The raw clay is almost tossed from the mine into the factory, to be set out into freight cars on the other side, a finished product, ready for the market.

At several of the works a great variety of sewer pipe and refractory materials is manufactured. Such works are indicated on the accompanying map as sewer pipe producers, because that product composes usually the greater part of their output.

Samples, when
collected.

Whenever possible, a section of the formation in which the worked clay occurs, was obtained, and this is published with the description of works. At each of the works samples of the clays were taken, representing as nearly as possible an average of the workable part of their respective beds. These samples have been analyzed at the Survey laboratory; but the results are withheld from this paper, pending further investigations.

Laclede fire clay.

In the illustration of an entrance to the Laclede fire clay mine, on the opposite page, the bed of fire clay may be seen in its relation to the bed of sewer pipe clay. The entry, at the mouth of which a man is standing, is driven in the bed of fire clay. Above it is five feet of solid sandstone, with a few inches of intervening beds, and overlying the sandstone is the bed of clay and clay shale used so largely in the manufacture of sewer pipe, and less extensively for terra cotta, pottery and paint. Just at this point the Loess clay has been stripped off, to be used in a mixture for the production of sewer pipes. The results of disturbance in the beds here, exhibited by the dip and by faults, is due to the subsidence of the beds into deserted chambers of the mine.

In the following descriptive list of works the location of each is indicated either by a number with reference to the county map or by a number and a letter with reference to the city map; this number, or number and letter, are enclosed in brackets and follow immediately the name of the firm.

Location.

Blackmer & Post (E, 16 and J, 12): — This company manufactures sewer and culvert pipes exclusively. It has two factories, one of which, erected in 1880, is situated on Ewing avenue, at the intersection with the Missouri Pacific railway, and the other, erected in 1887, is situated on Arsenal street and St.



Entrance to the Fire Clay Mine of the Laclede Sewer Pipe Company,
showing the sandstone roof and the beds of pipe clay above it.

Louis, Oak Hill and Carondelet railway. The company's clay pit is located on Cleveland avenue, just west of the Tamm road. Operations were begun in 1878. The capital invested amounts Capital and out-put. to about one hundred and fifty thousand dollars. In 1889 about thirty thousand tons of clay were consumed.

Christy Fire Clay Company (G, 18):—This company makes a specialty of washed pot clays, but it has lately undertaken the manufacture of fire brick, and kindred refractory materials, on a large scale. Its factories and clay mine are situated at "Christy," on the St. Louis, Oak Hill & Carondelet rail-Location. way. In 1889 about five thousand tons of high grade clay were used and sold.

The writer was unable to gain admittance to the mine, but obtained from the company the following section along the shaft, in descending series:—

1. Loess, yellow clay.....34 ft.
2. Drift, gravel..... 1 ft. 5 in.
3. Pipe clay.....14 ft.
4. Green shale..... 5 ft.
5. Slaty shale..... 4 ft. 5 in.
6. FIRE CLAY, the bed mined *..... 6 ft.

Coffin, Thomas, & Company (L, 6 and C, 15):—This company has its mine and one factory near Gratiot, on the Watson Location. road, and one factory and its general office on the Wabash railway, at the Douglass street crossing. Its products are pot clays, Product. glass-house pots, fire brick, and kindred refractory material. It began business in St. Louis, in 1884, as a branch of the Pittsburgh works. The capital invested is two hundred thousand Capital and production. dollars. About twelve thousand tons of fire clay were sold and used in 1889. The section of the mine shaft was unobtainable.*

Evans & Howard (E, 14):—This firm has its works and mine at Howard Station, on the Missouri Pacific and Frisco railroads. Location. It produces sewer pipes and all kinds of fire clay materials. It also sells a small amount of raw and washed clay. In 1889 it sold Product. and consumed about 60,000 tons of clay, while at present it is con-

* An extensive "dump" near the shaft was sampled for analysis and test.

THE CLAY INDUSTRY.

GENERAL REMARKS.

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* See sections on pages 21, 22, 23 and 25.

of the mine an undulating one. The fire clay is purest at the bottom of the bed, being full of iron pyrites at the top, while at other mines, the purest clay is found at the top and the impurities mostly at the bottom. Character of clay bed.

Jones, David (D, 13): — Mr. Jones has a fire clay mine, situated between Pierce, Cheltenham and Sublette avenues. He began work in 1883, and produced in 1889 about eight thousand tons of fire and potters clay, which was all consumed by the Evens & Howard firm. Location. Production.

There are two clay pits, and the geological section is probably the same as at the Wrisberg mine.

Stigmaria occur here also.

Laclede Fire Brick Manufacturing Company (D, 14): — This company makes a specialty of the manufacture of sewer pipes, fire bricks, and all kinds of fire clay material, and of a terra-metallic paving brick. The works are situated at Laclede, on the Missouri Pacific and Frisco railways. Operations were begun in 1855. In 1864 work was carried on by the firm of Hamilton & Green. The present company was incorporated in 1869. In 1889 from four to five thousand tons of crude clay were sold, and about ninety thousand tons of clay were consumed. Of the latter, a little over half went into refractory materials, and the rest into sewer pipes. Character of product. Location.

An extensive mine is opened by a drift in the bed of fire clay of the Coal Measures. From this bed the clay for the refractory products is obtained. The greater portion of the material which is used for sewer pipes, is obtained from the Loess, and from a heavy bed of pipe clay and shale which underlies the Loess. With this material, however, some fire clay is mixed. Source of material.

The following section, in descending series, was obtained here:—

- | | | |
|--|--------|----------|
| 1. Loess..... | 25 ft. | |
| 2. Clay shale, dark wine and sometimes greenish colored, very fissile, quite soft when mined, but hard and brittle when dry..... | 10 ft. | Section. |
| 3. Sandstone to conglomerate, composed mainly of fine, white quartz grains, cemented with a ferruginous clay; contains many nodules of siliceous limonite; is frequently cross-bedded; and occasionally has a fissile character..... | 5 ft. | |

4. Fire clay.....	6 inches.
5. Coal.....	2 "
6. FIRE CLAY, the bed which is mined *.....	7 ft.

Mitchell Clay Manufacturing Company (E, 14): — The works of this company are at No. 5700 New Manchester road. The chief product is fire brick. A small amount of farm drain tile is manufactured, for which about three hundred tons of clay were used in 1889.

The present consumption of clay, none of which is produced by this company, is about one thousand tons per day. The value of the plant is about twenty thousand dollars.

Missouri Fire Brick and Clay Company (D, 14): — The works of this company are situated at Cheltenham on the Missouri Pacific and Frisco railways. Work was begun in 1884, with a capital investment of about twenty thousand dollars. The product is almost wholly fire brick.

Parker and Russell Mining and Manufacturing Company (G, 17): — This company has its works and mine on the Morgan Ford road and Parker avenue. It is a large producer of sewer pipes and refractory materials, and makes a specialty of the production of gas retorts. In 1889 it produced about 1500 of the latter. The capital investment is about three hundred thousand dollars. Its business dates back to 1866.

The clay supply comes from the Coal Measures, and is raised from the mine through a double shaft which is one hundred and twenty feet deep. There was originally a coal mine here about eighty feet below the surface. The section could not be obtained. The bed of clay† has been somewhat squeezed and flexed. It varies in thickness from fifteen inches to about seven feet. It is underlain by sandstone, and overlain by shale and sandstone.

At the railroad bridge just southwest of the mine the following partial section, in descending series, was obtained: —

* From No. 6 a "mine run" sample of the fire clay was taken for analysis and test, and from No. 2 an average sample of the pipe clay (used here for manufacturing sewer pipes) was taken for the same purposes.

† A mine run sample was taken for analysis and test.

1. Typical Loess.....	8 ft.	
2. Jointed clay, seeming to pass into the Loess above.....	20 ft.	Section.
3. Ferruginous sandstone.....	8 ft.	
4. Clay shale, variegated color.....	14 ft.	

No. 4 may be the same bed of clay as that used for sewer pipes at the Laclede works.

Towle and Thorpe Fire Clay Company:—This company began work in 1881. It does not manufacture, and sells crude clay ^{Product.} only. In 1889 the production amounted to seven thousand tons.

Wrisberg Mining Company (E, 13):—The mine of this company is situated between League and Cheltenham and Lilly ^{Location.} avenues. The product is fire clay, pipe clay and “ocher” or paint clay. Work was begun in 1883, and in 1889 the production of all kinds of clay amounted to about twenty-five thousand ^{Product.} tons.

The fire clay is taken from a mine, the shaft of which is forty- ^{Source of clay.} seven feet deep. The other clays are taken from open cuts in the hill side.

The fire clay bed is remarkable for fossil stigmaria and calamites, which are found at or near the top of the bed.

The following is a section, in descending series, of the Coal Measure deposit, here, down through the fire clay. It is made from personal observation, combined with information furnished by Mr. Wrisberg :—

1. Loess.....	0-20 ft.	
2. Limestone, “tumble rocks”.....	0-5 ft.	
3. Clay, white and yellow, used for sewer pipe manufacture, called “bastard fire clay”.....	3-4 ft.	
4. Clay, yellow and red, sold for paint manufacture and for coloring plaster and mortar, called “ocher”.....	3 ft.	
5. Clay, gray to white, used for paint manufacture and filling..	1 ft. 6 in.	
6. Pipe clay, variegated, reddish brown and greenish, called “keel”.....	12 ft.	Section.
7. Sandstone	5-7 ft.	
8. Slaty shale.....	3 in.	
9. Coal.....	3 in.	
10. FIRE CLAY, becoming sandy towards the base.....	5-20 ft.	

THE PRODUCERS OF TERRA COTTA.

The terra cotta industry in St. Louis is one of the few successes of its kind west of the Mississippi river. Local clay is used, and an excellent grade of the ware is produced. The demand for the product is constantly increasing.

Terra cotta lumber has been made until lately when the venture failed, probably on account of some mismanagement, as there is a growing market for the product, and an abundance of satisfactory clay material to be had.

Artistic terra cotta is made of a high grade, and some very large and handsome figures have been produced.

The Missouri Terra Cotta Lumber Company (D, 14):— This company has its works at Cheltenham in the yard of the Missouri Fire Brick and Clay company. In 1889 it produced about twenty thousand dollars' worth of material, most of which was fire proof structural lumber, roofing, tile and drain pipe. Work is at present suspended.

The Winkle Terra Cotta Company (D, 14):— The works of this company are situated at Cheltenham on the New Manchester road. All varieties of terra cotta and tile are manufactured to order. Operations were begun in November, 1883, and the company is now almost the only successful producer west of the Mississippi river. The clays used come from the Coal Measures and the Loess deposits. Some is shipped from the vicinity of Glencoe in St. Louis county.

In 1884, 1885, 1886, about five hundred tons of clay per year were consumed, but in 1887, 1888 and 1889 the annual consumption amounted to about two thousand tons.

THE PRODUCERS OF POTTERY.

The pottery industry is at present confined to the city, where it is carried on in a small way by a number of producers. The clay used is a mixture, in varying ratios, of Coal Measure and Loess materials.

The product consists mostly of brown stoneware, such as milk pans, jars, jugs, and flower pots.

There is one Art pottery in St. Louis where beautiful wares Art pottery. are produced. Only custom work, however, is done, and the material used comes mostly from a distance.

Louis Gnauk (G, 18):— Mr. Gnauk has a pottery on the south side of Chippewa street and Eudora avenues. He began work about one year ago. The production is flower, coffee, "patent" Product. and milch pots and earthenware in general. The first year's product amounted to about twenty thousand flower pots, six thousand patent pots, and a small number of the other varieties.

A mixture of one part pipe clay and nine parts fire clay is used Material used. for the production of the pottery. Both of these clays are obtainable on the spot.

John Muttig (J, 12):— Mr. Muttig has a pottery at No. 3675 Manchester road. He produces stoneware and earthenware, Product. the former from fire clay brought from Union and Glencoe and the latter from the neighboring Loess clays. The value of his output for 1889 was about three thousand five hundred dollars.

Charles Schwarzhoff (I, 16):— This pottery is situated at No. 3107 Michigan avenue. Flower pots and a few milch pots constitute chiefly the product. Work was begun in 1860 and has been carried on at intervals to the present date. In 1889 about one hundred and thirty-five pots, ranging from two to four inches in diameter, were produced.

Loess or pipe clay is mixed with fire clay in the ratio of one Material used. to two. The plant is valued at four thousand dollars.

August Seeber (I, 17):— Mr. Seeber's pottery is located on Virginia avenue, between Cherokee and Miami streets. The product Product. consists of "patent," flower and milch pots, and a few flower vases. Work was begun about 1870.

The output for 1889 consisted of twenty thousand "patent" and milch pots, and eighty thousand flower pots.

Local Loess clay is mixed with fire clay (purchased from a distance) in the ratio of one to nine, for the manufacture of Material used. the above pottery. The plant is valued at twelve hundred dollars.

August Uhlemeyer (I, 17):— Mr. Uhlemeyer's pottery is situ-

Product.	ated at No. 3316 Gravois road. The principal product consists of flower and milch pots. Work was begun in 1867. In 1889, about eighteen thousand milch pots, and one hundred thousand flower pots were manufactured. Mr. Uhelemeyer mixes fire clay
Material.	and the least sandy portion of the Loess clay, in about equal proportions, for his uses. The plant is valued at sixteen hundred dollars.

THE PRODUCERS OF STRUCTURAL BRICK.

Distribution.	The structural brick works, with one or two exceptions, are confined to the city, from which, however, they will be driven before very long for want of available material. The Loess clays are used almost entirely, and an excellent building brick is produced. Very fine face and ornamental brick are also made, for local use, and for shipment to distant points.
Brick yards and quarries associated.	Brick yards are frequently located at stone quarries, leading to an economical method of disposing of the Loess clays which would otherwise have to be moved simply as stripping. As these clays range from fifteen to forty feet in thickness, it occasionally happens that stone quarrying can be carried on at a profit, only through being so aided by a brick yard.
Prices of brick.	Common brick bring in the St. Louis market from seven to eight dollars per thousand; front or face brick about twenty dollars per thousand, and ornamental brick, on an average, about fifty dollars per thousand.
Location and product.	<i>Bollmann, August</i> (L, 10):— Mr. Bollmann has a brick yard on Eighteenth street, between Cass avenue and O'Fallon street. The product is common brick, which are hand-made. Work was begun in 1870. In 1889 about one million bricks were made.
Location and product.	<i>Bergsicker & Bro.</i> (K, 7): — The works of this firm are situated at the junction of Florissant and Glasgow avenues. Hand-made common bricks constitute the product. Work has been carried on since 1870. The product for 1889 amounted to nine hundred thousand bricks. The clay used is hauled from Twentieth and Bissel streets.
	<i>Branahl, Charles</i> (E, 7): — Mr. Branahl has a brick yard on St. Louis avenue and King's Highway. He produces common,

hand-made bricks only. Work was begun in 1870. In 1889 he produced about one-quarter of a million bricks.

Buckwinkle, Frank (J, 6):—Mr. Buckwinkle has a brick yard on Prairie avenue, just east of Twentieth street. Hand-made, common bricks only are produced. Work was begun in 1882. The annual production is a little less than two million bricks. Location and product.

College Hill Press Brick Works (J, 5):—These works are situated on Broadway at College avenue. The product consists of common, stock and ornamental brick, though but few of the latter are made. In 1889 the production of all kinds amounted to nearly twenty-six million bricks. Work was begun in 1884. The company has a 'plant and property valued at one hundred and thirty-five thousand dollars, including twenty-three acres of clay land and three dry press machines. The market is a local one. Plant.

Compton Avenue Brick Works (J, 12):—These works are situated on the north-east corner of Atlantic and Compton avenues. The three principal varieties of brick are produced, the whole amount for 1889 being about eight million. Work was begun in 1886, with a plant valued at forty thousand dollars. The semi-dry process is used. Location and product.

Eureka Press Brick Company (L, 7):—The works of this company are at No. 4251 North Eleventh street. The company was incorporated in 1884, with a capital stock of twenty-five thousand dollars. It produces common and face brick, but almost wholly the former. Its production for 1889 amounted to about three million bricks. Two one-brick dry press machines are in use. Preparations are being made to manufacture ornamental brick. Plant.

Excelsior Brick Company (K, 9):—This firm has a brick yard at the corner of Elliott avenue and North Market street. Work was begun in 1883. Wet and dry machines are used. In 1889 about three and a half million bricks were made. Location.

Grote & Hilkerbaume (K, 7):—This firm has a brick yard on the corner of Twentieth and Ferry streets. Hand-made, common bricks constitute the product. Work was begun by this firm in 1882, but the yard has been worked since 1875. In 1889 the product amounted to eight hundred thousand bricks. Location. Product.

Location and product. *Humann, Frank* (E, 8):—Mr. Human has a brick yard on Union avenue, between Cote Brilliaute and Spalding streets. Hand-made, common bricks constitute the whole product. Work was begun in 1884. In 1889 not quite half of a million bricks were made.

Location. *Hydraulic Press Brick Company*:—This company has six yards which are located as follows: one at the intersection of Grand and Chouteau avenues (I, 13); one at the crossing of Kings Highway and the railway (F, 16); another at Cheltenham (D, 14); one at the crossing of the Wabash railway and the Manchester road (H, 12); one at the crossing of Kings Highway and the Frisco railway (F, 14); and one at the corner of Gravois road and Chippewa avenue (H, 18). The product is common, face or stock, and ornamental bricks. Business was begun in 1868 with a capacity of ten million bricks, which has been increased to nearly eighty million annually, and the company is now the largest producer in St. Louis. The dry process of manufacture is alone used. About thirty million bricks are carried from October to May, for winter work.

Product.

Markets. St. Louis is the largest market the firm has, and Chicago, to which large shipments are annually made, is the next in importance. Bricks are sent to New York, British Columbia, Seattle, San Antonio, Galveston, and Alabama and other States.

Location. *Ittner, Anthony* (J, 15):—Mr. Ittner's yard is situated on the south-west corner of California avenue and Sidney street. He produces common face and ornamental brick, but mostly the common variety. He began the business here about fifteen years ago. In 1889 his product amounted to thirteen million of the three varieties of brick, and this number is a fair average per year since he began the business. Mr. Ittner uses the dry press method, and works from two to five machines. St. Louis is the place of principal consumption, but he sells brick from the Gulf states to the Pacific coast. The value of the plant is about one hundred thousand dollars.

Product.

Markets.

Location. *Kuehn, August* (J, 5):—Mr. Kuehn has a brick yard on College avenue and Von Phul street. He produces hand-made bricks, only. Work was begun in 1882. About half a million

bricks were made in 1889. The clay is dug in winter, and wet tempered and moulded, by hand, in the summer.

Kulage & Menke (Y, 5):—This firm has a brick yard situated on the north side of College avenue, and on the west side of Von Phul street. Hand-made brick only are produced. Work was begun in 1882. In 1889 about one million bricks were made. Location and product.

Kuntz, Charles (L, 17):—Mr. Kuntz has a brick yard on Marine avenue, at Chippewa street. One “mud machine” is used, and many bricks are made by hand. In 1889 about two and one-half million bricks were produced. “

Kuntz, Fritz (I, 17):—Mr. Fritz Kuntz has a brick yard situated on the corner of Nebraska avenue and Utah street. The product consists of hand-made common brick. Work was begun in 1887. In 1889 about one and a quarter million bricks were made. “

Lyon Press Brick Co. (K, 17):—This company has works situated between Potomac and Cherokee avenues, just east of Broadway. Stock and common brick are produced. In 1889, the year work was begun, a little less than three million bricks were made. A “Lyon Press Brick” machine is used. “

Missouri Press Brick Co. (K, 18):—The works of this company are situated on the corner of Osage and Marion avenues. The company was organized in 1886, but work had been done here since 1884. In 1889 about two and one-half million of common, stock and ornamental brick were produced. The wet and dry processes are used about equally. St. Louis is the only market. “

Nieman, August H. (J, 17):—Mr. Nieman’s brick works are situated at Jefferson and Utah avenues. Work was begun there in 1885. Common and stock brick are made by hand. In 1889 the product amounted to a little over three and one-half million bricks. “

Oehler, Paul (K, 17):—Mr. Oehler’s works are situated on the south side of President street, near Broadway. Work was begun here in 1863, and for the last twenty years the annual output has been about three and one-half million bricks, mostly of the common variety. All work is done by hand. “

Location and
product.

Pahl, Henry (F, 17): — Mr. Pahl conducted a brick yard on Kings Highway, three blocks south of Arsenal street. Work was begun here in 1889, and about half a million common bricks were made, by hand. The establishment is now superseded by the *Tower Grove Brick Works*.

“ *Repping and Son, J. H.* (J, 16): — This firm has works situated between Nebraska and Wyoming streets. Work was begun in 1885. In 1889 about three million bricks were produced, most of which were of the common variety. One “mud machine” is used. The plant is valued at five thousand dollars.

“ *Scales, Thos. H.* (K, 8): — Mr. Scales has a brick yard situated on the east side of Jefferson avenue, between Herbert and Palm streets. The product consists wholly of hand-made common bricks. Work was begun in this yard in 1859. In 1889 about three-quarters of a million bricks were made.

“ *Schlingman, E.* (L, 7): — The works of Mr. Schlingman are situated on Penrose street, between Blair and Fourteenth streets. Only common hand-made brick are produced. Work has been carried on since 1886.

“ *Schlingman, Henry* (L, 7): — Mr. Henry Schlingman has a brick yard situated on Penrose street between Blair and Nineteenth streets. He produces only hand-made common brick. Work was begun in 1887. In 1889 he made nearly a million bricks.

“ *Schweer and Maes* (J, 19): — The works of this firm are situated on the east side of Broadway near Osceola. Common and stock brick only are produced. Work has been carried on since 1888 and brick are made by hand and by machine. In 1889 three million bricks were made. The value of the plant is five thousand dollars.

“ *Smith, T. S.* (K, 6): — Mr. Smith's brick works are situated on Broadway and Grand avenue. He produces mostly common brick, but a few stock and ornamental are made. The works have been operated for about eighteen years. The value of the plant alone is about twenty thousand dollars, and including the land it is about sixty thousand dollars. Four machines are in use, of these, two are semi-dry hammer machines and

Plant.

two are dry press machines. The production for 1889 for the three varieties of brick was a little over seven million bricks. St. Louis is the only market.

Spengemann, Edward (I, 20):—Mr. Spengemann has a brick yard on the east side of Michigan avenue and south of Termination street. Only hand-made, common bricks are produced. Work was begun in 1884. In 1889 about one and a quarter million bricks were made. Location and product.

Steinkamper, F. W.:—Mr. Steinkamper has two yards; one on Ashland avenue and Kings Highway (F, 7), and the other on Elliott avenue and Wright street (J, 9). In the latter he produces hand-made brick, and in the former, pressed brick by the wet process. He began operations in 1873, and in 1889 he produced three million common, and one million ornamental bricks. “

Stuckenberg, John (J, 17):—Mr. Stuckenberg's works are at Jefferson and Utah avenues. The chief product is common brick, but stock and a few ornamental bricks are manufactured. Work was begun in 1886. “

Tower Grove Brick Works.—See *Henry Pahl*.

Union Press Brick Company (F, 7):—This company has its works on the Natural Bridge road and the Kings Highway. The production consists of common, face and ornamental brick, and for 1889 the total of all kinds produced amounted to about thirty-eight million. The company was organized 1872 with an authorized capital of forty thousand dollars. Both the dry and wet processes of manufacture are used. St. Louis consumes the greater part of the product, but brick are sent to Washington, Minnesota, Texas and other states. Three hundred and fifty men and boys and eighty teams are employed. The company has sixty-five acres of clay land. Markets

Walkenhorst, F. W. (F, 12):—Mr. Walkenhorst has a brick yard situated on the north side of the Clayton road, east of Taylor avenue. The product consists entirely of common bricks, which are made by hand. Work was begun in the Spring of 1889, and during the remainder of the year six hundred thousand bricks were made. Twelve thousand bricks are now made daily, and a hand press is to be put in at once. Location and product.

STATISTICAL TABLES.

The following tables are compiled from the results of personal inquiry at each of the works. The totals which are given in the summary are undoubtedly smaller than similar ones for the present year would be, because of a natural growth of the clay industry, and because in 1889 building operations were not normally active.

Source of figures. In the first table the statistics of production are not given for the individual works. Some of the figures obtained were given the writer with the request that they be not published in detail, and as inferences might be drawn from such figures which would wrongfully injure a business firm, they are here only used included in a statement of the figures for a class of producers.

The figures for the number of kilns used at the different works should be considered in connection with the amounts of production, or the capacity which the respective works have. Otherwise they have a relative value only in a limited way, because kilns vary so considerably in their size and style.

Locations of
works.

Where more than one set of coördinates or number is given in the column of "Position on Map," the references are to the different factories, pits or brick yards which are conducted under the one proprietary head.

**STATISTICS OF THE STRUCTURAL BRICK INDUSTRY OF THE CITY
OF ST. LOUIS FOR THE YEAR 1889.**

The location of brick yards may be found on the map of the city, accompanying this article, by the coördinates given in this table.

Position on Map.	PROPRIETOR.	Number of Kilns.	Output of Stock Brick.	Output of Orna- mental Brick.	Output of Common Brick.	Value of Product.
L, 10	Bollman, Aug.	1	.....	.....	1,000,000	\$5,750
K, 7	Bergsicker & Bro.	2	.....	.....	900,000	5,850
E, 7	Branahl, Chas.	1	.....	.....	215,000	1,183
J, 6	Buckwinkle, Frank.	2	.....	.....	1,800,000	10,000
J, 5	College Hill Press Brick Wks.	6	9,000,000	500,000	16,000,000	354,000
J, 12	Compton Avenue Brick Wks.	4	1,500,000	500,000	6,000,000	50,000
L, 7	Eureka Press Brick Co.	2	150,000	.....	2,800,000	20,900
K, 9	Excelsior Brick Co.	7	.....	.....	3,500,000	23,625
K, 7	Grote & Hilkerbaume.	2	.....	.....	800,000	4,800
E, 8	Humann, Frank.	2	.....	.....	405,000	2,027
I, 13; H, 18; F, 17; D, 14; F, 14; H, 12;	Hydraulic Press Brick Co.	69	20,000,000	4,000,000	50,000,000	975,000
J, 15	Ittner, Anthony.	5	1,200,000	800,000	11,000,000	106,000
J, 5	Kuehn, August.	1	.....	.....	480,000	2,880
J, 5	Kulage & Menke.	1	.....	.....	1,000,000	5,400
L, 17	Kuntz, Chas.	3	405,000	.....	2,000,000	14,430
I, 17	Kuntz, Fritz.	2	.....	.....	1,285,000	7,080
K, 17	Lyon Press Brick Co.	3	25,000	.....	2,250,000	14,000
K, 18	Missouri Press Brick Co.	4	425,000	200,000	1,875,000	15,000
J, 17	Nieman, Aug. H.	3	135,000	.....	3,500,000	20,000
K, 17	Oehler, Paul.	4	200,000	20,000	3,000,000	22,800
F, 17	Pahl, Henry.	1	.....	.....	500,000	3,350
J, 16	Reaping, J. H. & Son.	3	55,000	.....	2,500,000	21,565
K, 8	Scales, Thos. H.	2	.....	.....	640,000	3,328
L, 7	Schlingman, E.	2	.....	.....	1,155,000	6,640
L, 7	Schlingmann, Henry.	2	.....	.....	900,000	4,950
J, 19	Schweer & Maes.	3	50,000	.....	2,950,000	18,062
K, 6	Smith, T. S.	4	500,000	50,000	6,500,000	42,750
I, 20	Spengemann, Edward.	2	.....	.....	1,200,000	6,900
J, 9 & F, 7	Steinkamper, F. W.	5	.....	1,000,000	3,000,000	32,250
J, 17	Stuckenberger, Jno.	3	100,000	.....	2,500,000	14,625
E, 17	Tower Grove Brick Works.	1	.....	.....	See Henry Pahl.	
F, 7	Union Press Brick Co.	18	11,000,000	1,300,000	24,700,000	470,250
F, 12	Walkenhorst, F. W.	2	.....	.....	600,000	3,300
	Totals.	172	44,745,000	8,370,000	156,955,000	\$2,288,794

TABLE OF PRODUCERS OF POT CLAY, CRUDE CLAY, SEWER PIPES, CLAY REFRACTORY MATERIALS &c., IN THE CITY
AND COUNTY OF ST. LOUIS.

The location of clay works and mines may be found upon one of the maps accompanying this article by the co-ordinates or number given in this table.

Position on Map.	Proprietor.	Location.	Character of Product.	No. Kilns.	No. Clay Pits.
D, 14.....	Laclede Fire Brick Manufacturing Co....	{ "Laclede," on the "Frisco" and Mo. P. ry.....	{ Sewer pipes, fire brick, paving, &c.....	27	1
E, 14.....	Evens & Howard.....	{ "Howard's," on the "Frisco" and Mo. P. ry.....	{ Sewer pipes, fire brick, paving, &c.....	25	3
G, 17.....	Parker & Russell Mining and Mfg. Co....	Morgan Ford road and Parker avenue.....	{ Sewer pipes, gas retorts, fire brick, pot clay, &c.....	19	2
E, 16, & J, 12	Blackmer & Post.....	{ Ewing Ave. and Mo. P. ry.; also Arsenal St. and St. L., O. H. & C. ry.....	Sewer pipes.....	21	1
G, 18.....	Christy Fire Clay Co.....	{ "Christy," on St. L. O. H. & C. ry.....	{ Fire clays and clay refractory materials...	6	1
L, 6, & C, 15	Thomas Coffin & Co.	{ Douglas St. and Wabash R. R.; also Watson road, near Gratiot.....	{ Fire clays and clay refractory materials...	9	1
124 (county)	William Jameson.....	{ Barthold's Valley.....	Crude & washed pot clay.....	.....	1
E, 13.....	Wrisberg Mining Co....	{ Between League, Cheltenham and Lilly avenues.....	{ Fire and potter's clay and ochres.....	.....	1
D, 13.....	David Jones.....	{ Between Pierce Cheltenham and Sublette avenues.....	Fire and potter's clay.....	.....	1
D, 14.....	Missouri Fire Brick and Clay Co.....	{ "Cheltenham," on "Frisco" and Mo. P. ry.....	Fire brick.....	3	1
E, 14.....	Mitchell Clay Manufacturing Co.....	No. 5700 New Manchester road.....	Fire brick.....	4	.....
D, 14.....	Winkle Terra Cotta Co.....	"Cheltenham," New Manchester road.....	Terra cotta, tiles, &c.....	.....	.....
D, 14... ..	Missouri Terra Cotta Lumber Co.....	{ "Cheltenham," on "Frisco" and Mo. P. ry.....	{ Terra cotta lumber and porous earthenware.....	.....	.....
C, 16.....	Towle & Thorpe.....	.....	Crude clay.....	.....	1

J, 13.....	John Muttig.....	No. 3675 Manchester road.....	{ Stoneware and earth- enware	2	.....
H, 18.	Louis Gaunk.....	Chippewa and Eudora avenues.....	{ Stoneware and earth- enware	1	.....
I, 17.....	August Seeber.....	Virginia avenue, bet. Cherokee and Miami..	{ Stoneware and earth- enware	1	.....
I, 17.....	August Uhlemeyer.....	No. 3316 Gravois road	{ Stoneware and earth- enware	1	.....
I, 16.....	Chas. Schwarkopf.....	No. 3107 Michigan avenue.....	{ Stoneware and earth- enware	1	.....
K, 19.....	Wash Street Art Pottery.....	No. 2185 Wash street.....	{ Stoneware and earth- enware	1	.....
Totals.....			Art pottery.....	120	14

STATISTICS OF THE INDUSTRIES MENTIONED IN THE ABOVE TABLE FOR THE YEAR 1889.

CHARACTER OF PRODUCT.	No. of Firms Engaged.	No. Tons of Clay Produced or Used.	Value of Product.
Washed pot clay.....	4	7,020	\$ 58,000
Sewer pipes.....	4	112,000	672,000
Fire brick, retorts, &c.....	7	119,855	869,000
Crude clay.....	5	49,500	48,000
Terra cotta.....	1	8,000	50,000
Terra cotta lumber.....	1	6,000	20,000
Pottery.....	6	335	5,570
Totals.....	28	297,700*	\$1,722,570*

* These figures include clay which was sold by local producers to local manufacturers in a raw state. The amount of such clay was perhaps thirty thousand tons, valued at seventy-five cents to a dollar per ton.

THE STONE INDUSTRY.

GENERAL REMARKS.

The geological formations of St. Louis City and county furnish to the industries handling stone, limestone, sandstone and a low grade of marble.

Limestone: — The limestones have been largely quarried for common purposes, the most general use being for foundations, paving and macadam. Less extensively, they have been quarried and dressed for a variety of dimension work. They are also used largely for the production of lime.*

Sandstone: — The sandstones are used for foundations to a small extent, and have been quarried for dimension stone, but they are not durable.

Marble: — A number of the limestones are sufficiently crystalline to pass for marble. Some of these make an excellent dimension stone, but they have been little quarried.

THE COAL MEASURE STONE.

In the Coal Measures, limestones occur which answer for common uses, and the micaceous sandstone, which is supposed to constitute the superior part of the lower measures, furnishes a rather poor building material.

THE LOWER CARBONIFEROUS STONE

The Lower Carboniferous rocks furnish a sandstone (the Ferruginous Sandstone of the general section), which is scarcely better than the micaceous sandstone. Immediately below this Ferruginous Sandstone, however, come the important beds of the St. Louis Limestone, descriptive sections of which are given in the notes on stone quarries beginning on page 42.

*Some of the beds of the St. Louis Limestone have been successfully used for lithographic work. No bed however is uniformly of the requisite quality, and the cost of selection of available material would seem to preclude the development of an industry for the production of lithographic stone.

This formation is quarried most extensively for foundation material and macadam. Many of its beds are particularly well adapted for the production of the latter. The lower beds will furnish very large blocks of handsome and durable dimension stone, and it seems probable that in the near future there will be a considerable industry producing such material.

The Keokuk Limestone of the general section has workable beds of a semi-crystalline fossiliferous stone which is handsome, takes a fair polish, and is probably durable. Large blocks are obtainable from these beds.

THE LOWER SILURIAN STONE.

From the Keokuk to the Trenton formation no economically important stone occurs. In the Trenton are some thick beds of semi-crystalline, highly fossiliferous limestone, which will furnish an excellent dimension stone. Many of the Trenton beds which appear to be serviceable, are, however, unfit for use in building, owing to a structural peculiarity by reason of which the stone suffers rapidly under the influence of weather. On exposure it becomes thoroughly honey-combed and, in this condition, it is frequently used for ornamental purposes about lawns and gardens.

Defects of Trenton stone.

From beneath the Trenton Limestone, in the western part of the county, the First Magnesian Limestone crops out and exposes some heavy beds of beautifully colored stone. The more crystalline of these will furnish a good dimension stone, but the greater part of the beds exposed seem prone to a rapid submission to the action of the weather.

First Magnesian Limestone.

Beneath the First Magnesian Limestone there are occasionally exposed, in the extreme western part of the county, beds of the Saccharoidal Sandstone which are capable of furnishing, as they do at Pacific and Crystal City, the highest grade of sand for glass making.

Saccharoidal Sandstone.

The following table shows the geological distribution of the different quarries. Each individual opening known to have been worked in 1889 is included and the quarries are assigned to formations according to Shumard's classification.

TABLE SHOWING THE GEOLOGICAL DISTRIBUTION OF ACTIVE STONE QUARRIES IN ST. LOUIS CITY AND COUNTY, FOR THE YEAR 1889.

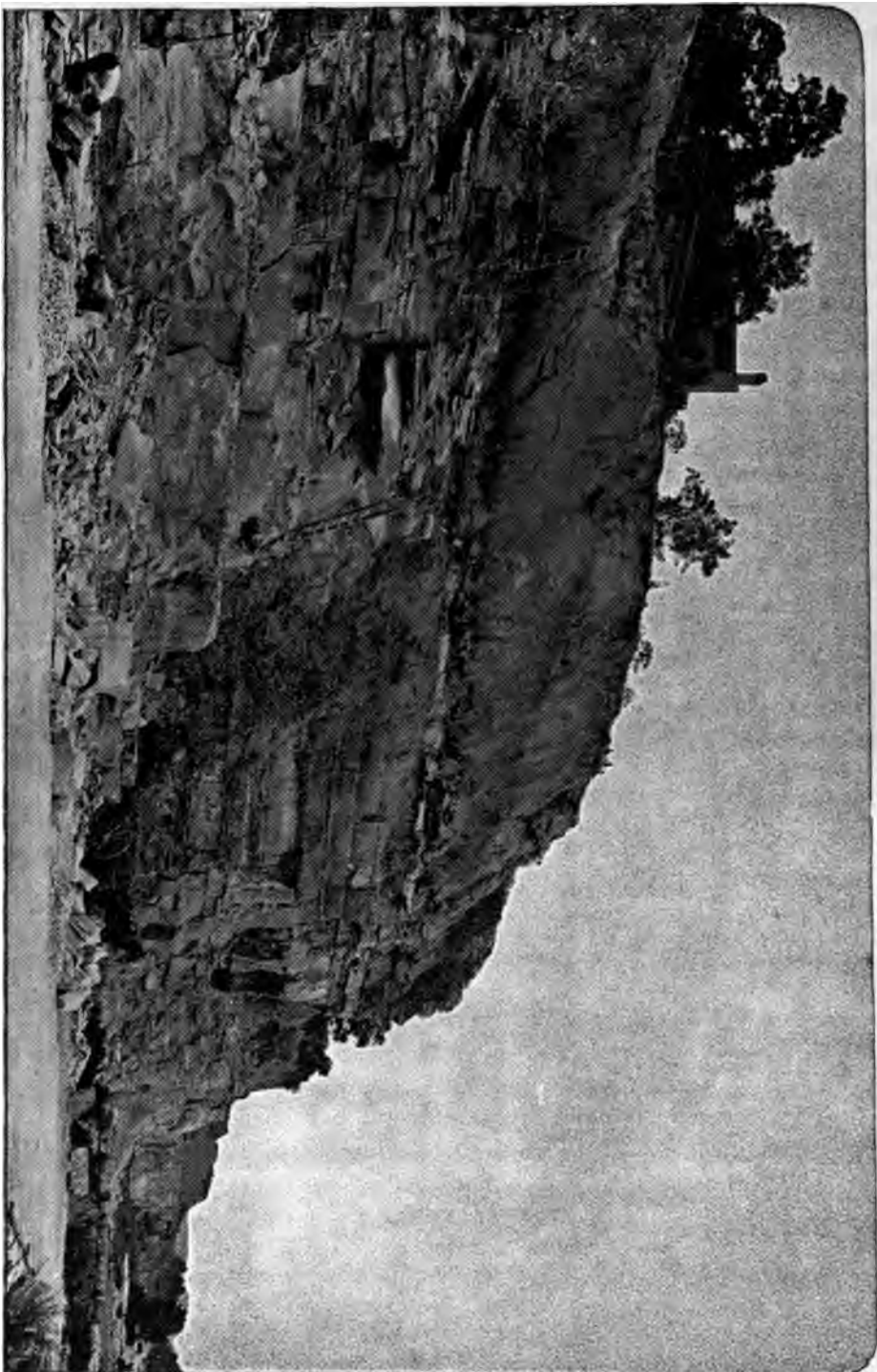
KIND OF PRODUCT.	ST. LOUIS LIMESTONE.	KEOKUK.	BURLINGTON.	TRENTON.	FIRST MAGNESIAN.
STONE	67	8	0	0	1
LIME	2	0	1	10	0

A DESCRIPTIVE LIST OF STONE QUARRIES.

The following descriptive list gives what general information the writer could obtain relating to the individual stone quarries. It is meant to be used in connection with other parts of the paper, such as the maps, where the geological and geographical location of quarries is shown, the table of analyses, where the composition of numerous beds of limestone is exposed, and the statistical tables, where the character, amount and value of the product of the quarries is given.

Plant of quarries. A comparatively small amount of machinery is used at the St. Louis quarries. Many of the quarries are small, shallow openings, worked for macadam and foundation stone, without the aid of any machinery. Some of the large and deep quarries have a steep, winding road to the surface, up which all the product is hauled in wagons, and, as many of these quarries have a natural drainage through subterranean passages, it is possible to dispense with pumping machinery. A class, including a large number of quarries, is the bluff quarry, which are opened along the face of old river bluffs, as open cuts. Here, for the production of stone for common uses, machinery is not necessary. Many of these quarries are to be found along the bluffs of the Mississippi river, where railroad facilities are close at hand. Most of their output, however, goes to a local market, and is hauled to its destination in wagons. Similarly situated, but without an immediate local market, are the quarries near Vigus, in the old bluffs of the Missouri river. These latter quarries aim to produce dimension stone, and such stone can be shipped by rail from here at a profit.

Bluff quarries.



BLUFF QUARRIES ON THE MISSISSIPPI RIVER.

Near the foot of Cahokia Street.

Illustrating a bluff quarry, in distinction to a sunken quarry. The Loess stripping, the ledges of the limestone, and the manner of quarrying are also shown.

The working of the thick lower beds of the St. Louis formation into dimension stone, for which they seem to be well suited, calls for channeling machines. A few of these are now in use, and it is probable that they will be more extensively introduced in the near future. Use of channeling machines.

The distribution of quarries, excepting those in the river bluffs, seems to be determined largely by the thickness of the stripping which is found above the workable stone. The stripping is composed of the Loess clays and sands, the Drift (sand and pebbles), residual clay and decomposing limestone.

The illustration opposite this page is of a series of quarries in the bluff along the Mississippi river. This bluff is included in the cross section printed on page 74 in connection with the lime analysis, and one of the quarries shown is that of Martin Lorentz, Bluff quarries. where a section was sampled from summit to base for analysis, the results of which are given under analysis numbers 24 to 42, inclusive. The general character of the beds, the amount of stripping and the manner of working the quarry are shown in this illustration.

The illustration opposite the next page is intended to show the general features of one of St. Louis' largest sunken quarries. The view is of the south end of the quarry, and shows the stripping, Sunken quarries. the crushing machines with the wagons below it receiving their load of crushed stone, the building containing the engine room, etc., and the heaps of riprap and macadam lying about in the quarry.

In the sections which are given are descriptions of the important or striking features of all the exposed beds at a quarry. It is evident from a study of these sections that a considerable variety of products for a quarry is necessary. Usually only a few beds at any quarry are suitable for dimension work, except the lighter kinds, such as window sills, etc. Other beds are used for macadam, paving, riprap, building stone, etc., according to their qualities and adaptability to the production of a given class of material. It will be seen in the following descriptive list that the product of the individual stone quarries is generally of a very varied character. Information in sections.

THE QUARRIES IN ST. LOUIS CITY.

All of the quarries within the city limits are in the St. Louis Limestone formation.

Location and
product.

Albernacius, Frank, and Adam Kern (L, 17):— Mr. Albernacius and Mr. Kern operate small quarries in the bluff immediately adjoining Mr. Lohrum's quarry. The product consists of macadam, paving and dimension stone. These quarries have been worked eighteen and nine years respectively.

Allen, E., and Knaus and Willis (J, 19): — These quarries joining each other, are situated about a fourth of a mile south of Meramec street and just west of the Iron Mountain and Southern railway tracks. The product consists mostly of dimension and building stone. The quarries are in the face of an old river bluff.

Following is the section here, in descending series:—

	FEET. INCHES.	
	FEET.	INCHES.
1. Stripping	6	
2. Limestone, gray, fine grained, in six inch layers.....	2	
3. Limestone, gray, fine grained, compact.....	2	6
4. Limestone, gray, fine grained, compact.....		6
5. Limestone, dark gray to drab, fine grained.....	1	8
6. Limestone, light gray	6	
7. Limestone, light gray.....	1	
8. Limestone, very thin layers		5
9. Limestone, thin layers, with shale partings.....	2	
10. Limestone, gray, compact.....	1	
11. Limestone, gray, fine grained, in two layers.....	3	6
12. Limestone, dark gray, rather coarse grained.....	2	6
13. Limestone, brownish, impure, thin layers.....	10	
14. Limestone, inaccessible, in beds six to thirty-six inches thick	6	2
15. Limestone, thin layers, jointed and weathered.....	7	
16. Limestone, gray, fine grained, in three layers.....	5	
17. Limestone, gray and brown.....	2	6
18. Limestone, gray, fine grained, in two twelve inch layers..	2	
19. Limestone, gray, carries thin layers of chert.....	3	
20. Limestone, gray, fine grained, in two twelve inch layers..	2	
21. Limestone, dark gray, fine grained.....		6
Total thickness of rock.....	67	3

Section.

Location.

Baldwin, Henry (I, 20):— Mr. Baldwin's quarry is situated between Itaska and Maeder streets, east of Pennsylvania avenue. It



STIEFEL AND RUCKERTS QUARRY—LOOKING SOUTH.

Illustrating a large and deep sunken quarry in distinction to a bluff quarry.

has been worked continuously since 1872, when it was opened. The product is mostly building and dimension stone. The quarry Product. is two hundred and thirteen feet long, by one hundred and thirty feet wide, and exposes the following columnar section, in descending series:—

	FEET. INCHES.		
1. Loess	15		
2. Residuary clay mixed with the gravel of the drift.....	12		
3. Limestone partially decomposed.....	5	10	
4. Limestone, gray and brown, siliceous, coarse-grained, contains patches of calcite, and, at the top and bottom concretions of chert....	7		Section.
5. Limestone, gray, very coarse-grained, crystalline and fossiliferous.....		3	
6. Limestone, gray, fossiliferous in two or more layers.....	2	6	
7. Limestone, gray, coarse-grained, in two or more layers....	4	6	
8. Limestone, gray, fine and coarse in grain in many layers...	6		
Total thickness of rock.....	26	1	

Bambrick-Bates Construction Co., First Quarry (N, 9-2):—

This quarry is situated on Madison street, between Main and Second streets. It was opened in 1867, and has, since, been Location. worked continuously. It is three hundred feet long, one hundred and twenty feet wide, and eighty feet deep. Stone for all common purposes is quarried.

Bambrick-Bates Construction Co., Second Quarry (N, 9):—

This quarry occupies about one-half the block between Clinton, Location. Madison, Main and Second streets. It was opened in 1886, and produces stone for all common purposes.

The following columnar section is exposed, in descending series:—

	FEET. INCHES.		
1. Residuary clay and soil.....	3		
2. Limestone, weathered and decomposing.....	9		
3. Limestone, gray to brownish, fine and coarse grained....	1	8	
4. Limestone, gray, coarse grained, in five or six layers....	2	10	
5. Limestone, gray, fine grained, cherty.....	1	2	
6. Limestone, nearly white, very siliceous.....	1	2	
7. Limestone, dark gray, coarse, sub-crystalline.....	1	4	8
8. Limestone, dark gray, coarse, numerous cavities lined with calcite crystals	2	3	
9. Shale and limestone in thin layers.....		7	
10. Limestone, gray, fine grained	3	6	
11. Shale and limestone in thin layers.....		5	

Section.	FEET. INCHES	
	FEET.	INCHES
12. Limestone, gray, vary-grained.....	1	8
13. Limestone, gray, fine grained.....	1	8
14. Limestone, gray, coarse grained, fossiliferous.....	1	8
15. Limestone, gray, coarse grained, fossiliferous, in several layers.....	4	10
16. Limestone, lavender, very fine grained, chert concretions, two layers.....	1	8
17. Limestone, dark gray, fine grained.....		4
18. Limestone, brown and lavender, coarse grained, crystalline, in three layers.....	2	
19. Limestone, brownish, coarse grained, three layers.....	1	
Total thickness of rock.....	37	9

Barnett, Wm. H. (J, 12) : — Mr. Barnett has a quarry which is situated just south of Bernard and east of Cardinal avenues. It was opened in 1889. The product consists of macadam, paving, dimension stone and riprap. The quarry is about three hundred and twenty-five feet long by three hundred feet wide. The stripping of Loess has been removed and made into bricks. It is soon to be worked on a much larger scale than it is at present.

The following section, in descending series, was obtained here :—

Section.	FEET. INCHES.	
	FEET.	INCHES.
1. Limestone, decomposing.....	8	
2. Limestone, gray, uniform grain, contains corals.....	3	1
3. Shale, very soft.....		6
4. Limestone, gray, fine grained, calcite veins.....		6
5. Limestone, gray, crystalline, varying in texture.....	3	8
6. Limestone, gray, in two layers, calcite veins, fossiliferous.....	3	4
7. Limestone, gray, varying in texture, concretionary at bottom, upper four or five feet coarse grained and fossiliferous.....	6	
8. Limestone, dark gray, concretionary.....		4½
9. Limestone, light drab, uniform fine texture.....		7
10. Limestone, light drab, very fine grained, concretionary near top.....	1	4
11. Limestone, very dark drab, fine grained, calcite veins.....		7
12. Limestone, dark gray, concretionary.....		8
13. Limestone, drab, lithographic.....		
Total thickness of rock.....	28	7½

The beds have a slight easterly or north-easterly dip.

Brocksmith, H. (C. 14): — Mr. Brocksmith has a quarry at Clifton Heights, just north-west of the Missouri Pacific Railway station. It was opened about thirty-five years ago, and has been worked by the present owner for the last eight years. The product consists of paving, macadam, building stone and a little dimension stone, in the quarrying of which two machine drills are used. The quarry is about one hundred feet long by thirty-five feet wide. The stripping of Loess is disposed of by making bricks of it.

Location and
product.

The following section, in descending series, was obtained here: —

	FEET. INCHES.		
1. Loess, lower two feet gravel.....	10-20		
2. Limestone, decomposing and weathered....	6	6	
3. Limestone, gray, soft, in three ten inch layers.....	2	6	
4. Limestone, gray, fine grained, soft.....		8	
5. Limestone, gray, soft, weathers into two twelve inch layers.....	2		Section.
6. Limestone, light gray, compact, yellowish when weathered, in four to six inch layers.....	9		
Total thickness of rock.	20	8	

Byrnes, Thomas (J, 10): — Mr. Byrnes has a small quarry which is situated on Magazine street, just east of Mr. Cavanaugh's quarry. The product is small and consists mostly of building stone.

Location and
product.

Cavanaugh, T. E. (J, 10): — Mr. Cavanaugh has a quarry which is situated on the south-east corner of Magazine street and Garrison avenue. It was opened about twenty-three years ago. The product consists of building stone, paving stone and macadam. One three-inch Ingersoll drill is used. The stone is hauled to the surface in wagons, up an inclined road.

The following section, in descending series, was obtained here: —

	FEET. INCHES.		
1. Loess.....	10-14		
2. Limestone, gray, even textured, good dimension stone, in four layers, from twenty to thirty inches thick.....	8	6	
3. Limestone, weathers into layers about ten inches in thickness	5		Section.
4. Limestone, gray, soft, weathers into a thirty inch top and an eighteen inch bottom layer.....	4		

		FEET.	INCHES.
Section.	5. Limestone, light gray, compact, divides in places into two layers. The upper one is six and a half feet thick, and has numerous concretions of chert arranged along a bedding plane. The lower one is three and a half feet thick, and is marked with stylolites.....	10	
	6. Limestone, very dark gray, fine grained, but not uniformly so.....	1	
	7. Limestone, light gray, compact in two layers.....		10
	8. Limestone, dark gray, compact, soft.....	1	6
	9. Limestone, light gray, soft, in four layers.	8	6
Total thickness of rock.....		39	4

Devereux and Sons (G, 7) :—The quarry operated by this firm is situated on Marcus avenue, between Osage and Loraine streets. Building stone is the chief product. The quarry was opened in 1870. It is about one hundred and twenty-five feet long, seventy-five feet wide, and exposes the following columnar section, in descending series:—

		FEET.	INCHES
Section.	1. Loess, drift, residuary clay and decomposing limestone....	5-20	
	2. Limestone, light gray, even grained, in three to five layers, of which the upper ones are very fossiliferous.....	4	
	3. Limestone, drab, fine-grained, brittle, fossiliferous, in layers from three to ten inches thick.....	5	
	4. Limestone, drab, fine grained, brittle, calcite veins, fossiliferous, several layers.....	4	
	5. Limestone, banded gray and brown, coarse grained.....	2	
	6. Limestone, drab, fine grained, dark colored chert concretions and layers.....	1	2
	7. Limestone, very dark gray, calcite patches, chert concretions	2	1
	8. Limestone, lavender, very fine grained and compact, brittle, lithographic, in four layers two to seven inches thick....	1	6
	9. Limestone, gray, rather coarse grained.....	1	2
	10. Limestone, gray, fine grained.....	1	2
	11. Limestone, dark gray, in three to five layers.....	2	4
Total thickness of rock.....		24	5

Engleman, A. O. (M, 15) :—Mr. Engleman has a quarry which is situated at the foot of North Trudeau street, west of the Missouri Pacific railway tracks. It was opened in 1870, and for ten years was quarried for the purpose of producing lime. It is about two hundred and fifty feet long and one hundred and

twenty-five feet wide. The product now consists of dimension and building stone, macadam and paving. Two Ingersoll drills and a channeling machine are in use. Stone is handled by derricks.

The following section, in descending series, was obtained here:—

	FEET. INCHES.	
1. Clay and decomposing limestone.....	16	
2. Limestone, thin weathered beds.....	17	
3. Limestone, gray, hard, compact.....	2	3
4. Limestone in thin layers.....		10
5. Limestone, gray, hard, concretionary.....		10
6. Limestone, greenish, soft, chloritic.....	2	6
7. Limestone, grayish, in thin layers.....		10
8. Shale		4-6
9. Limestone, dark gray, fine grained.....		8
10. Limestone, light gray, fine grained, stylolites at top.....	3	6
11. Limestone, white, coarse grained, semi-crystalline.....	2	
12. Limestone, white, lithographic.....	2	
13. Limestone, gray, rather coarse grained, much jointed.....	1	
14. Limestone, gray, fine grained, hard, compact.....	4	
15. Limestone, light gray, fine grained.....	1	8
16. Limestone, yellowish		4
17. Limestone, very light gray, fine grained, compact.....	1	6
18. Limestone, gray, fine grained, compact, in two two foot layers.....	4	
19. Limestone, light gray, chert concretions.....	4	
20. Limestone, light gray, lithographic, much jointed.....	1	
21. Limestone, light gray, lithographic.....		6
Total thickness of rock.....	50	10

Eyerman, G., Estate, First Quarry (I, 20):— This quarry is situated east of Virginia avenue, near Maeder. The product is mostly building stone, but a little dimension stone, macadam and paving stone, is quarried. The quarry has been worked since 1882. It is about ninety feet wide and three hundred and twenty feet long.

The following section, in descending series, was obtained here:—

	FEET. INCHES.	
1. Loess	6-18	
2. Residuary clay, mined with the gravel of the drift.....	1	
3. Limestone, partially decomposed.....	2	
4. Limestone, light gray, fine grained.....	3	6

		FEET. INCHES.	
Section.	5. Limestone, gray, coarse and fine grained, few fossils, several layers	5	6
	6. Limestone, gray, compact, siliceous.....	5	
	7. Limestone, gray, numerous concretions of chert.....	1	4
	8. Limestone, dark gray, fine grained, compact and hard in two layers.....	4	4
	9. Limestone, lavender, very fine grained, and compact, brittle, calcite veins.....	1	
	10. Limestone, very dark gray, sub-crystalline.....	1	10
	11. Limestone, gray and yellow, fine grained, siliceous.....	2	5
	12. Limestone, light and dark gray, cherty		9
	13. Limestone, drab, very fine grained.....	1	1
	14. Shale, greenish blue, sandy.....		3-5
	15. Limestone, gray and bluish, fine grained.....	1	2
	16. Limestone, light gray, fine and coarse grained.....	3	4
	17. Limestone, light gray, fine grained.....	1	
	18. Limestone, white and grayish, fine grained	2	10
	19. Like number 18, but contains much chert.....	3	2
	Total thickness of rock.....	40	7

Eyerman, G. (I, 13):— Mr. Eyerman has a quarry which is situated on the corner of Carr Lane avenue and Rutger street. It was opened in March, 1889. The product consists of macadam, paving, building and dimension stone.

The section here is about the same as that at Christian Piepers quarry, given on p. 58.

Friederichs, Jacob (I, 20):— Mr. Friederichs has a quarry situated at the intersection of Minnesota avenue and Maeder street, which was opened about seven years ago. The quarry is rectangular in shape, is about sixty feet long by fifty feet wide, and is drained by a subterranean channel.

The following section, in descending series, was obtained here:—

		FEET. INCHES.	
Section.	1. Soil and Loess.....	8-16	
	2. Gravel and residuary clay.....	16	
	3. Limestone, partially decomposed.....	2-6	
	4. Limestone, light gray, soft.....	3	
	5. Limestone, light gray, several layers interstratified with chert	4	4
	6. Limestone, light gray, in thin layers, calcite veins.....	7	
	7. Limestone, very light gray, chert concretions and layers near the top.....	1	3

	FEET. INCHES.	
8. Limestone, brownish, siliceous, numerous chert concretions and layers near the top and bottom.....	5	
9. Limestone, gray, fossiliferous, coarse grained, in two layers	3	8
10. Limestone, gray, fossiliferous, calcite veins.....	1	
11. Limestone, light gray, coarse grained, several layers.....	6	
12. Limestone, light gray, fine grained, soft, two layers.....	3	
Total thickness of rock.....	36	9

Section.

Fruin, Bambrick & Co., First Quarry (H, 12):—This quarry is situated at the junction of Cabanne avenue and Papin street. There are two shallow openings, one on each side of the Missouri Pacific railway. Work was begun here about two years ago, and has consisted mainly of the removal of stone for the production of macadam.

Location and product.

Fruin, Bambrick & Co., Second Quarry (C, 14):—This quarry is situated on the "Frisco" railway at Clifton Heights. The product consists mostly of macadam and building stone. Some paving is also produced.

The following section, in descending series, was obtained here:—

	FEET. INCHES.	
1. Loess.....	30	
2. Limestone, much broken and more or less decomposed....	10	4
3. Limestone, gray, fine grained, compact, in three ten inch layers.....	2	6
4. Limestone, gray, full of dark colored flinty concretions....		6
5. Limestone, gray, soft, occasional chert concretions.....		10
6. Limestone (covered with debris).....	2	
7. Limestone, light gray, compact, in two layers each thirty inches thick.....	5	
Total thickness of rock	21	2

Section.

Fruin, Bambrick & Co., Third Quarry (I, 13):— This quarry is situated on the south-east corner of Grand and Chouteau avenues. Work was begun by the present operators in May, 1890, with the intention of producing paving stone, macadam and rubble. But little work has been done as yet.

Location.

The following section, in descending series, was obtained here:—

Section.	FEET. INCHES.	
	FEET.	INCHES.
1. Loess.....	8	
2. Limestone, weathered in thin layers.....	20	
3. Limestone, yellow, soft and shaly.....		2
4. Clay, yellow, soft, laminated		6
5. Clay carrying flinty nodules.....		4
6. Shale, green, soft.....		6
7. Limestone, bluish gray, very fine grained, compact, in two layers, respectively three feet and a foot and a half thick.....	4	6
8. Limestone, gray, in six to ten inch layers.....	4	
9. Limestone, gray, rather coarse grained, in two eighteen inch layers.....		3
10. Limestone, gray, hard, compact.....	5	
Total thickness of rock.....	38	0

Location and
product.

Fruin, Bambrick & Co., Fourth Quarry (H, 12):— This quarry is situated near the junction of Cabanne and Chouteau avenues. The product consists of macadam, paving, building stone and rubble. The quarry is about thirty-five feet deep. There is a thin stripping of loess and decomposing limestone.

Grund, Louis (K, 19):— Mr. Grund has a large quarry which is situated west of the Iron Mountain and Southern railway track, near Meramec street. The quarry is two hundred feet long and sixty feet deep. The product consists of macadam, building stone and paving. The quarry is in the same bluff as the Work House* quarry and the sections at the two quarries are very similar.

Heman Bros. (O, 10):— This firm has a quarry which is situated in the block west of Main Street and south of Brooklyn. Stone for most all the common uses is produced. Following is the columnar section made at the quarry, in descending series: —

FEET. INCHES.	
1. Soil, loess and decomposing limestone.....	4-12
2. Limestone, in thin layers	4
3. Limestone, in two beds (inaccessible)..	8 9
4. Shale, greenish, alternating with limestone.....	1 8
5. Limestone, gray to bluish, fine grained.....	1 8
6. Limestone, gray, vary-grained, cherty in upper part.....	2
7. Shale, greenish, with nodules of limestone.....	4
8. Limestone, dark gray, rather coarse grained.	3 10
9. Limestone, light gray, shaly.....	2

* For note see p. 62.

	FEET. INCHES.		
10. Limestone, light gray, fine grained, occasional concretions of chert.....	1	9	
11. Limestone, gray, fine grained.....	1	6	
12. Limestone, gray, coarse grained crystalline.....	1		
13. Limestone, drab, shaly.....		3	Section.
14. Limestone, gray to white, fine grained, cherty.....	2	1	
15. Limestone, gray and brownish, in beds from one to six inches thick.....	7	6	
Total thickness of rock.....	38	7	

Hogan, E. W. (K, 6): — Mr. Hogan has a quarry which adjoins the Perkinson Second Quarry on the Eleventh street side. The product consists of macadam, building stone and paving. Stone is hoisted from the quarry by derricks. Location and product.

The section is the same here as that at the latter quarry.

Hogan, M. (L, 7): — Mr. Hogan has a quarry on Penrose south of Blair avenue. The product consists of macadam. "

Following is the section in descending series: —

	FEET. INCHES.		
1. Loess.....	20		
2. Limestone, gray, fine grained, compact, in three thirty-six inches layers.....	9		
3. Shale.....		1-3	Section.
4. Limestone, gray, fine grained.....	1	8	
5. Limestone, thin beds, in some places two to three feet thick, in others two to six inches thick.....	15		
Total thickness of rock.....	25	10	

Hogan and Moran (J, 9): — This firm has a quarry which is situated at the north-east corner of Magazine street and Garri-son avenue. It was opened fifty-one years ago, and was worked by R. Kingen for seventeen years. Mr. Hogan then worked it for twenty-five years when it went into the hands of the present firm which has since operated it continuously. The product consists of macadam, building stone and paving. Stone is loaded, in the quarry, into movable wagon beds, hoisted to the surface and delivered to the wheels of the truck. Location. Product.

The upper part of the section is the same as that at Cavanaugh's, as given above. The entire section is as follows, in descending series: —

Section.	FEET. INCHES.	
	FEET.	INCHES.
1. Limestone, same as at Cavanaugh's.....	39	4
2. Limestone, gray to drab, hard, crystalline.....	3	
3. Limestone, full of chert concretions.....		10
4. Limestone, light gray, hard, considerably faulted.....	4	
5. Limestone, drab, lithographic, considerably faulted.....	2	6
6. Limestone, light gray, cherty, lithographic, in three layers	6	
7. Limestone, dark gray, siliceous, splits easily, in three		
layers	2	10
8. Shale, greenish, very persistent.....		2-4
9. Limestone, gray, hard, fine grained, compact, in two layers	5	
Total thickness of rock.....	63	9

Location and
product.

Kempf, Conrad (I, 20): — Mr. Kempf has a quarry situated next to Mr. Friedericks, which was opened in 1883. Dimension and building stone, and macadam are produced. The quarry is drained by a subterranean stream. It is about one hundred and eighty feet long by one hundred feet wide, and exposes the following columnar section, in descending series:—

Section.	FEET. INCHES.	
	FEET.	INCHES.
1. Loess.....	10-20	
2. Residuary clay, mixed with the gravel of the drift.....		18
3. Limestone, partially decomposed	6	
4. Limestone, drab, uniform fine grained, highly fossiliferous,		
in two and sometimes three layers.....	5	
5. Limestone, gray and light brown, chert layers and concre-		
tions.....	3	
6. Limestone, light gray, uniform fine grained.....	1	2
7. Limestone, dark and light gray, rather fine grained, quite		
hard.....	1	10
8. Limestone, gray, coarse grained, in three layers.....	1	8
9. Limestone, dark gray, coarse grained, fossiliferous.....	4	10
10. Same as number 9.....		6
11. Limestone, gray, coarse and fine grained, in a variable		
number of layers.....	3	8
Total thickness of rock.....	27	8

Kern, Adam: — See *Albernacius*.

Location and
product.

Kinealy and Sons (K, 7): — This firm has a quarry which is situated in the block between Florissant, Twenty-second, Penrose and Angelica streets. It was opened in the spring of 1889. Building stone, curbing and macadam are the chief products. The quarry is about sixty feet long, fifty feet wide and exposes the following columnar section, in descending series: —

	FEET. INCHES.		
1. Loess, drift and decomposing limestone.....	26		
2. Limestone, lavender, fine grained, very fossiliferous.....	1		
3. Limestone, gray, coarse grained, crystalline.....	1	6	
4. Limestone, gray to lavender, coarse grained in several layers.....	4		Section.
5. Limestone, gray to drab, fine grained, very fossiliferous...	2	6	
6. Limestone, gray and lavender, fine and coarse grained, in layers from two to ten inches thick.....	6	6	
Total thickness of rock.....	15	6	

Knaus and Willis (J, 19):— See Allen.

*Krug and Zesch (I, 20):—*This firm has a quarry at the corner of Minnesota and Delor avenues. It was first worked in 1869. The output consists of macadam, paving, building stone and "furnace rock." The quarry is drained by a subterranean stream. It is about two hundred feet long, one hundred feet wide, and exposes the following vertical section, in descending series: —

	FEET. INCHES.		
1. Loess, yellow clay.....	5-20		
2. Drift (gravel) and residuary clay.....	1		
3. Limestone, decomposed	3		
4. Limestone, very siliceous.....	5		
5. Limestone, in three beds, gray, fine grained, lower and upper beds rather siliceous.....	3-4		
6. Limestone, in two beds, almost white, rather coarse grained, suture joints.....	2	6	
7. Limestone, gray, very fine grained, compact, brittle, called "glass ledge".....	1	3	Section.
8. Limestone, dark gray and brown, numerous calcite crystals, disintegrates rapidly.....	1	10	
9. Limestone, gray, compact.....	1	2	
10. Limestone, in thin layers, white and gray, cherty.....	4		
11. Limestone, in thin layers, white and gray.....	5		
12. Limestone, gray, fine grained, chert concretions and layers	4		
13. Limestone, gray, coarse grained, siliceous.....	4		
14. Limestone, gray, coarse grained	1	3	
15. Limestone, gray, coarse grained.....		4	
16. Limestone, gray, coarse grained, fossiliferous	1	8	
17. Limestone, gray, coarse grained, easily disintegrated		7	
18. Limestone, gray, rather coarse grained, hard.....	1	8	
Total thickness of rock.....	40	3	

Location and
product.

Lohrum, John C. (L, 17):—Mr. Lohrum has a quarry, situated in the face of the Mississippi river bluff, near the foot of Cahokia street, and on the Iron Mountain & Southern railway. The chief product is macadam and building stone; but some paving and dimension stone is quarried. The section here is about like that given below, at Martin Lorentz' quarry, although it is a little higher in the series, and a few different ledges come in at the base. The quarry has a face of three hundred feet in length. It was opened in 1883.

Lorentz, Martin (L, 17):—This quarry is situated by the side of the Iron Mountain & Southern railway track, near Cahokia street. It is one of the series of quarries which are worked in the face of the Mississippi river bluffs, and may be seen in the illustration on page 41. The principal product is building stone and macadam. The following section,* in descending series, shows the character of the material used:—

	FEET. INCHES.	
1. Loess, the stripping.....	10-30	
2. Drift of pebbles.....	1	
3. Limestone (Analysis No. 20), light gray, darker towards top, fine grained.....	1	6
4. Limestone (Analysis No. 21), like No. 3.....	1	10
5. Limestone (Analysis No. 22), light, yellow and gray, soft		8
6. Limestone (Analysis No. 23), light and dark gray, varying texture, compact, brittle, hard.....	2	10
7. Limestone (Analysis No. 24), gray, fine grained, jointed..	2	6
8. Limestone (Analysis No. 25), light gray, fine grained, color and texture somewhat variable.....	2	6
9. Limestone (Analysis No. 26), dull gray to yellowish, harder towards base.....	4	2
10. Limestone (Analysis No. 27), brownish and gray, coarse grained, shaly near top, two layers varying in thickness	3	
11. Limestone (Analysis No. 28), like No. 10.....	2	4
12. Limestone (Analysis No. 29), dull gray, very fine grained.		5
13. Limestone (Analysis No. 30), drab, hard, brittle, lithographic.....		11
14. Shale		1
15. Limestone (Analysis No. 31), gray, hard.....		9
16. Limestone (Analysis No. 32), light drab, with dark bands.	1	10
17. Limestone (Analysis No. 33), dark gray, carries layer of chert	3	11

* For the results of analyses of average samples of the beds of this section, see page 76.

	FEET. INCHES.		
18. Limestone (Analysis No. 34), light drab, fine grained, layer of chert three feet from base varying in thickness	8	2	
19. Limestone (Analysis No. 35), dark gray, geodes, lined with calcite crystals.....		8	
20. Limestone (Analysis No. 36), light gray, soft chert, con- cretions near top.....	2		
21. Limestone (Analysis No. 37), gray, coarse grained.....	1	10	Section.
22. Limestone (Analysis No. 38), like last, but poorer quality		10	
23. Limestone (Analysis No. 39), dark gray to brownish, lower sixteen inches cherty.....	4		
24. Limestone (Analysis No. 40), brown, otherwise like No. 23	3	9	
25. Limestone (Analysis No. 41), drab, hard, brittle, fine grained, lithographic	1	6	
26. Limestone (Analysis No. 42), dark gray, coarse grained, hard, in three ledges.....	3	4	
Total thickness of rock.....	56	4	

Mohun, Patrick (I, 13):—Mr. Mohun's quarry adjoins that of Christian Piepers, and occupies about half of the same opening, which is two hundred and seven feet long and one hundred and fifty feet wide. Work is at present suspended. Location.

O'Meara, John B., First Quarry (F, 17):—This quarry is one of three which are conducted by Mr. O'Meara. It is situated on the south side of Euclid, and on the west side of Ashland avenues. It has been worked since 1876. The product consists of dimension stone, paving, macadam, foundation stone, etc. Steam Product. saws have been used for about five years, and at present a channeling machine is in use.

The outline of the quarry is roughly circular at the surface, and is about four hundred yards in circumference. The following section in descending series, is exposed :—

	FEET. INCHES.		
1. Stripping, Loess, drift and decomposing limestone.....	20		
2. Limestone (Inaccessible).....	10		
3. Limestone, gray, jointed in four layers.....	3	8	
4. Limestone, gray, lithographic, in many layers.....	11		
5. Limestone, gray at top, growing very dark downwards, containing much chert, especially at the top	2	6	Section.
6. Limestone, gray, fine grained.....		10	
7. Limestone, dark and light gray, concretionary.....		3-5	
8. Limestone, gray, uniform texture, best dimension stone in quarry	2	9	

		FEET. INCHES.	
		FEET.	INCHES.
Section.	9. Limestone, brownish, coarse grained, fossiliferous, several layers.....	8	9
	10. Limestone, gray to bluish, fine grained, many layers, fossiliferous.....	7	3
	11. Limestone, dark gray, fine grained, many layers.....	7	6
	12. Limestone, gray, fine grained, fossiliferous, numerous cavities	1	6
	13. Limestone, gray to brown, coarse grained	1	
	14. Limestone, brownish, quite soft	1	4
	15. Limestone, dark gray, coarse grained, siliceous.....	1	
	16. Limestone, dark gray, with horizontal streaks of brown, fine grained.....	5	8
	17. Limestone, gray, fine grained, concretions of chert at top..	3	8
	18. Limestone, dark gray, fine grained.....	3	
	19. Limestone, very dark gray, coarse grained		5
	20. Limestone, gray, fine grained.....		11
	21. Limestone, dark gray, fine grained.....		7
	22. Limestone, gray, vary in texture from coarse to fine.....	2	6
	23. Limestone, dull gray, coarse grained	3	8
	24. Limestone, light gray, fine grained, soft, dresses to white..	3	2
	25. Limestone, gray, with greenish tinge, breaks into thin layers	1	4
	26. Limestone, gray, coarse grained	2	
	Total thickness of rock.....	81	4

The beds have distinct northeasterly dip.

Location and
product.

O'Meara, John B., Second Quarry (K, 9) : — This quarry is situated at the corner of Twenty-fifth and Montgomery streets, and occupies nearly a whole block. It was opened about twenty-five years ago. No dimension stone is quarried at present, although formerly a considerable amount of it was produced. The output is mostly paving, foundation stone and macadam. One four inch Ingersoll drill is used. Stone is hoisted from the quarry in the movable beds of wagons by derricks. The stripping varies here from a few inches to thirty feet in thickness. The upper twenty-five feet of limestone are very flinty, and are worth but little, though a few of the layers may make good curbing.

"

O'Meara, John B., Third Quarry (F, 12) : — This quarry is situated at number 4400 Clayton road. The product consists mostly of curbing and paving, and a small amount of building stone. Hand drills and a derrick are used.

The following section was made in the quarry, in descending series:—

	FEET. INCHES.		
1. Loess.....	40		
2. Limestone, decomposing.....	5		
3. Limestone, irregular, cherty and hard layers.....	5		
4. Limestone, in layers, varying from two to ten inches.....	10-11		Section.
5. Limestone, dark gray, hard, in four layers, used for curbing.....	3		
6. Limestone, gray, hard, chert concretions, stylolites.....	2	6	
7. Limestone, gray, fine grained, used for paving altogether..		10	
8. Limestone, gray, fine grained, in two layers, used for curbing.....	1	6	
9. Limestone, gray, uniform fine texture, weathers into several layers.....	2	6	
Total thickness of rock.....	31	4	

Perkinson, J. E. & Bro., First Quarry (J, 7):— This quarry is situated near the corner of Harrison and Grand avenues. It was opened in 1870, and has been worked by the present owners for sixteen years. It is about one hundred and thirty-five feet deep. Stone for all the common purposes is quarried. Location.

The following section, in descending series, was obtained here:—

	FEET. INCHES.		
1. Loess.....	40		
2. Limestone, decomposing and weathered.....	10		
3. Limestone, gray, compact, in two layers.....	5		
4. Limestone, in thin layers.....	20		
5. Limestone, gray in two thirty inch layers.....	5		
6. Limestone, in thin layers.....	4		
7. Limestone, dark gray.....	1		
8. Limestone, several layers.....	10		
9. Limestone, very thin layers.....	1		
10. Limestone, gray, variable texture.....	6-7		
11. Limestone, gray, chert concretions, in three layers.....	6	6	Section.
12. Limestone, white, compact, uniform texture, weathers dark in places.....	1	6	
13. Limestone, gray, coarsely crystalline.....	3	6	
14. Limestone, light gray, compact.....	1	6	
15. Limestone, white and greenish, in alternating layers which vary from ten to twenty-four inches in thickness.....	5	6	
16. Limestone, light gray, compact, in three layers.....	4	10	
Total thickness of rock.....	86	4	

Location. *Perkinson, J. E. & Bro., Second Quarry (K, 6):*—This quarry is situated near the corner of Bissell street and Broadway. Stone for all the common purposes is quarried.

Following is the section, in descending series, obtained here:—

		FEET.	INCHES.
	1. Loess	15	
	2. Limestone, weathered.....	5	
	3. Limestone, shaly.....	1	6
	4. Limestone, gray.....	8	
	5. Limestone, dark gray and blue, crystalline, calcite veins, flinty in places.....	3	
	6. Limestone, yellow and brown, changes color abruptly, cross bedded.....	1	8
Section.	7. Limestone, light and dark gray, in layers varying in thick- ness from twenty to thirty-six inches.....	9	8
	8. Limestone, gray, in two to ten inch layers.....	15	
	9. Limestone, dark gray, fine grained.....	4	
	10. Limestone, light gray, fine grained.....	1	
	11. Limestone, gray, coarse grained, in four layers.....	1	8
	12. Limestone, light gray, in three layers	2	6
	13. Limestone, gray, fine grained, in two layers		10
	14. Limestone.....	1	8
	15. Limestone, in six to twelve inch layers.....	15	
	Total thickness of rock.....	65	6

Location and product. *Pickel, Conrad (I, 13):*—Mr. Pickel has a quarry which is situated on the northeast corner of Hickory street and Theresa avenue. It was opened in 1883. The product consists of macadam and building stone.

Section. The section here is about the same as that at Christian Pieper's quarry, given below, except that the shale layer changes into a shaly limestone.

Location and product. *Pieper, Christian (I, 13):*—Mr. Pieper has a quarry which is situated on the southeast corner of Carr Lane avenue and Hickory street. It was opened in 1886. The product consists of macadam and building stone.

The following section, in descending series, was obtained here:—

		FEET.	INCHES.
	1. Loess.....	2	
Section.	2. Limestone, gray, decomposing, in thin beds.	10	
	3. Limestone, dark gray, soft.....	1	6
	4. Limestone, gray, fine grained, compact, in four layers.....	4	

	FEET. INCHES.		
5. Limestone, dark gray, compact, in three eighteen inch layers.....	4	6	Section.
6. Shale.....	1	6	
7. Limestone, gray, fine grained, jointed, three layers.....	5		
8. Limestone, light gray, compact, in two twelve inch, and one thirty-six inch layer.....	5		
Total thickness of rock.....	31	6	

Pendergast, George (D, 7):—Mr. Pendergast has a quarry which is situated on Florence avenue, three or four blocks north of Easton avenue. It is a small shallow quarry about three hundred feet long by one hundred and twenty-five wide. It was opened in 1889. The product consists of building stone, macadam, dimension stone and riprap. Location and product.

The following section, in descending series, was obtained here:—

	FEET. INCHES.		
1. Loess.....	4-6		Section.
2. Drift.....		6	
3. Limestone, decomposing.....	5		
4. Limestone, drab, lithographic.....		5	
5. Limestone, brownish, numerous crystals of calcite.....		8	
6. Limestone, gray, fine grained, on weathering exposes many crinoid stems.....	2		
7. Limestone, light and dark gray, uniform texture.....	1	10	
8. Limestone, light gray and brown, numerous calcite crystals and corals, fine grained.....	4	10	
9. Limestone, gray and brown, fine grained, siliceous.....	1	8	
10. Limestone, light gray, finely crystalline.....	2		
Total thickness of rock.....	17	0	

The beds here dip southeasterly.

Ridemeyer (L, 7):—Mr. Ridemeyer has a quarry which is situated at Newhouse avenue and Nineteenth street. The quarry is about seventy-five feet square and forty-four feet deep. The product consists of rubble and macadam. Location and product.

Following is the section here, in descending series: —

	FEET. INCHES.		
1. Loess.....	30		Section.
2. Limestone, irregular thin layers.....	5		
3. Limestone, gray, coarsely crystalline.....	2	6	
4. Limestone, gray, coarse grained.....	2	6	

		FEET.	INCHES.
Section.	5. Shale		6-10
	6. Limestone, gray, compact.....	2	6
	7. Limestone, irregular thin layers.....	15	
	Total thickness of rock.....	28	2

Stiefel and Ruckert, First Quarry (G, 6):— This quarry is situated between Cora and Marcus avenues, on the north side of the Natural Bridge road. Stone for all common purposes is quarried. It was opened in 1888. It is three hundred feet long, sixty-four feet wide, and exposes the following columnar section, in descending series: —

		FEET.	INCHES.
Section.	1. Loess.....		14
	2. Residuary clay mixed with the gravel of the drift.....	1	
	3. Limestone, partially decomposed.....	1	
	4. Limestone, brown, coarse grained.....	2	
	5. Limestone, drab, fine grained, compact, hard and brittle ..		9
	6. Limestone, gray, coarse grain.....		3
	7. Limestone, light drab, fine and coarse grained, lithographic in places.....	6	
	8. Limestone, bluish, fine grained.....	2	6
	9. Shale, bluish and green, hard, merges into number 8.....		2-7
	10. Limestone, dark brown to drab, contains numerous crystals of pyrites.....		8
	11. Shale, bluish green, in layers, with thin layers of limestone	1	
	12. Limestone, very dark gray, coarse grained, quite large masses of pyrites		11
	13. Limestone, dark gray, fine grained, suture joints, fossiliferous, pyrites especially near top.....	5	
	14. Limestone, light gray, fine grained.....	3	8
	15. Limestone, gray, coarse grained.....	2	
	Total thickness of rock.....	26	2

Stiefel and Ruckert, Second Quarry (M, 15):— This quarry is situated in the city at the foot of Barton street, on the north side of the Iron Mountain and Southern Railway. It is one of the largest quarries in the city, being very deep and having a large rock face to be worked. Its shape is somewhat oval. A view of the south end of the quarry is illustrated opposite page 42. It was opened in 1863. At present its chief product is macadam. Two Rand drills and a No. 4 Gates' crusher are in use.

The following section,* in descending series, shows the character of the beds:—

	FEET.	INCHES.	
1. Loess, the stripping of this quarry.....	4		
2. Limestone, much jointed and weathered.....	20		
3. Limestone (Analysis No. 1), light gray, coarse grained, stylolites at bottom.....	2	5	
4. Limestone (Analysis No. 2), gray and drab, finer grained, splits into layers, lower third lithographic in character, fossiliferous.....	3	11	
5. Limestone (Analysis No. 3), gray, fine grained, highly fossiliferous.....	3	10	
6. Limestone (Analysis No. 4), gray, much jointed, granular.	1	4	
7. Limestone (Analysis No. 5), soft drab, lithographic, brittle, conchoidal fracture.....	1	3	
8. Limestone (Analysis No. 6), gray to brownish, coarse, granular, stylolites.....	4	7	
9. Limestone (Analysis No. 7), same as No. 8, but variable in grain, few fossils.....	2	3	
10. Limestone (Analysis No. 8), soft drab to brownish, irregularly bedded, brittle, conchoidal fracture.....	3	2	
11. Clay shale, soft greenish.....		3	
12. Limestone (Analysis No. 9), almost white, fine grained, conchoidal fracture, decomposes readily.....		10	Section.
13. Limestone (Analysis No. 10), soft drab and brownish, irregularly bedded, fine grained, conchoidal fracture...	4	3	
14. Limestone (Analysis No. 11), soft drab and brownish, fine grained, conchoidal fracture.....	4	6	
15. Limestone (Analysis No. 12), almost white, irregularly bedded, brittle, conchoidal fracture, stylolites.....	1	8	
16. Limestone (Analysis No. 13), like number 15, but slightly darker.....	3	3	
17. Clay shale, greenish.....		2	
18. Limestone (Analysis No. 14), gray to drab, fine wavy bedding lines, fine grained, stylolites.....		10	
19. Limestone (Analysis No. 15), light drab, brittle, conchoidal fracture.....	1	11	
20. Limestone (Analysis No. 16), light brown, many bedded, lithographic, cross bedded in places.....	4	5	
21. Limestone (Analysis No. 17), drab, coarse grained, granular stylolites.....	2	9	
22. Limestone (Analysis No. 18), same as No. 21, but finer grained.....	1	10	
23. Limestone (Analysis No. 19), two or more beds, dark gray, easily dressed.....	6		
Total thickness of rock	75	5	

* For analyses of average samples of the stone from the respective beds of this section, see page 76.

St. Louis Stone Masons Quarry (I, 13): — This is a small quarry situated on the north-east corner of Carr Lane avenue and Hickory street.

The following section, in descending series, was obtained here:—

Section.	FEET. INCHES.	
	FEET.	INCHES.
1. Loess	3	
2. Limestone, thin weathered layers.....	12	
3. Shale	1	
4. Limestone, gray, compact.....	7	
5. Limestone, light gray, compact, in two twelve inch layers	2	
6. Limestone, light gray, crystalline.....	5	
7. Limestone, thin shaly layers	8	
Total thickness of rock	35	0

Watson Construction Company (H, 13): — This firm has a quarry which is situated on the south-west corner of Grand and Chouteau avenues. It was opened in December, 1889. The section here is the same as that given of the Fruin, Bambrick & Company's Third Quarry, p. 50.

Wieman, William (G, 6): — Mr. Wieman's quarry is situated on the south-west corner of Cora and Margaretta avenues. The product is mostly building stone and macadam. The quarry was opened in 1880. It is sixty feet long, thirty feet wide and exposes the following columnar section, in descending series: —

Section.	FEET. INCHES.	
	FEET.	INCHES.
1. Loess	5-30	
2. Residuary clay and decomposing limestone.....	5	
3. Limestone, light gray.....		4
4. Limestone and chert in thin alternating layers.....	1	6
5. Limestone, light gray.....	4	
Total thickness of rock.....	5	10

Work House Quarry (K, 19): — This quarry is situated at the foot of Meramec street, on the Iron Mountain and Southern railway. It has been opened about forty years. The most important product is macadam. The laborers employed are all convicts. The quarry is deep, large and somewhat oval in shape. The following section,* in descending series, shows the character of the beds:—

* For analyses of the stone from the respective beds of this section see page 77.

	FEET. INCHES.	
1. Loess as stripping.....	5-20	
2. Limestone (Analysis No. 43), in broken and weathered beds	6	6
3. Limestone (Analysis No. 44), dark drab, fine grained.....	2	9
4. Limestone (Analysis No. 45), light drab, fine grained, two inch layer of chert near top.....	2	4
5. Limestone (Analysis No. 46), drab and yellowish, fine grained grades in places to No. 4 without separation....	1	3
6. Limestone (Analysis No. 47), cross bedded, alternating layers of chert and limestone.....	6	6
7. Limestone (Analysis No. 48), gray and brown, rather fine grained, several beds of limestone from two to twelve inches thick, two layers of chert two to six inches thick.....	3	10
8. Limestone (Analysis No. 49), gray, brown and drab, coarse grained.....	4	2
9. Limestone (Analysis No. 50), gray, fine grained, laminated, four to five beds from one to six inches thick.....	2	
10. Limestone (Analysis No. 51), lavender, lithographic, hard, brittle, conchoidal fracture, very fine grained... ..	1	4 Section.
11. Limestone (Analysis No. 52), very dark gray, rather fine grained, slightly cross bedded.....	1	
12. Limestone (Analysis No. 53), same as No. 11.....	3	9
13. Limestone (Analysis No. 54), gray and drab, fine grained hard, carries oblong and spherical masses of chert.....	2	4
14. Limestone (Analysis No. 55), and chert in alternate but non-continuous layers.....	12	
15. Limestone (Analysis No. 56), dark gray, considerable chert	3	6
16. Limestone (Analysis No. 57), dark and light gray, overlaid by two feet of chert with little limestone, laminated, cross bedded.....	3	
17. Shale.....		1
18. Limestone (Analysis No. 58), gray, drab and greenish, coarse grained, stylolites, fossiliferous, chert band at top.....	2	3
19. Shale.....		4
20. Limestone (Analysis No. 59), light yellow, drab and gray, large balls of chert a foot or more in diameter near top, fossiliferous and geodal.....	6	
21. Limestone (Analysis No. 60), gray to brown, line of chert at top, stylolites, soft, fine and coarse grained.....	4	9
Total thickness of rock.....	69	4½

QUARRIES IN ST. LOUIS COUNTY.*

Location. *Boehm, Fritz (50)*:— Mr. Boehm has a quarry near Bobring, in the St. Louis Limestone. It has about four hundred feet of rock face, in which the following section, in descending series, is exposed:—

		FEET.	INCHES.
	1. Loess.....	10	
	2. Limestone, much decomposed.....	2	
	3. Limestone in several layers, with shaly partings, several layers are about 10 inches thick, suture joints.....	6	
Section.	4. Limestone, lavender, fine grained, scattered concretions of bluish chert.....		8
	5. Limestone and Shale, like No. 3, except layers not so thick.	6	6
	6. Limestone, gray to lavender, fine grained, crystalline, fossiliferous, in three layers.....	2	
	Total thickness of rock.....	17	2

Location. *Crystal Spring Quarry Co. (47)*:— This firm quarries stone, which is probably of the St. Louis Limestone, in an old bluff on the Missouri river, near Vigus Station, on the St. Louis, Kansas City, and Colorado railway. Work was begun in 1889. The product consists of building stone, riprap, etc., but is soon to include dimension stone which the company intends to produce on a large scale. The quarry is connected with the railway by a switch about one half of a mile long. The company controls several hundred yards face of workable stone. There are three openings in the bluff from each of which stone is removed by the use of derricks to freight cars on which it is shipped.

Section. The section here is the same as given below for the quarry of the Watson Construction Co., which is close at hand. A sample for analysis was collected here from beds numbers 4 to 10 (inclusive) of this section.

Location. *Doering, J. H. (51)*:— Mr. Doering has a quarry situated on the Carondelet Branch railway, southwest of Bobring, in the St. Louis Limestone. It is connected with the railway by a half mile switch. The quarry has a workable face about eight hun-

* A few of the county quarries mentioned in the tables do not appear in this descriptive list. None of such are, however, large producers, so far as could be learned.

dred feet long. The product consists of dimension stone, macadam and riprap.

Eureka Quarry Co. (57):— This company has a quarry which is situated on the Gravois road about an eighth of a mile northeast of Afton, in the St. Louis Limestone. Work was begun in 1889. The product consists of building stone and macadam.

Location and
product.

The following section, in descending series, was obtained here:—

	FEET. INCHES.		
1. Stripping, residuary clay and decomposing limestone.....	5		
2. Limestone, lavender, lithographic.....	1	1	
3. Limestone, gray, crystalline.....	1	10	
4. Limestone, same as last but fossiliferous	2		
5. Limestone, light gray, crystalline, calcite veins, fossiliferous, in several layers.....	3		Section.
6. Limestone, light gray, crystalline, in four layers.....	3	6	
7. Limestone, gray, coarse grained, crystalline, calcite, in thin layers	2	3	
8. Limestone, gray, fine grained, crystalline.....		6+	
Total thickness of rock.....	14	2	

Fabrick, Philip, and Marshall (53):— This firm has a quarry situated about one-fourth of a mile west of the Doering and Munsen quarries, and about three hundred yards from the Carondelet Branch railway. The stone quarried belongs to the St. Louis Limestone.

Location.

The following section, in descending series, was obtained here:—

	FEET. INCHES		
1. Soil and residuary clay.....	6		
2. Limestone, partially decomposed.....	5		
3. Limestone, dark gray, fine grained.....	1	6	
4. Limestone, gray to brown, coarse grained, soft.....	3		
5. Limestone, dark gray, coarse grained.....	1	10	
6. Limestone, gray to brown, vary grained.....	1	8	Section.
7. Limestone, dark gray, lithographic, in three layers.....	2	6	
8. Limestone, buff, shaly and soft.....	1	8	
9. Limestone, dark drab, lithographic.....	1	9	
10. Limestone, very dark drab, fine grained, crystalline, calcite veins, two layers separated by a thin bed of brown shale	2	10	
11. Limestone, dark gray, lithographic, in three layers.....	2	4	
12. Limestone and shale, in three alternating layers.....		3-6	
13. Limestone, dark gray to lavender, fine grained.....	1	2	
Total thickness of rock.....	25	8	

Location and
product.

Glendale Quarry Co. (55):— This company has a quarry on the Carondelet Branch railway about half way between Kirkwood and Webster, in the St. Louis Limestone. It was opened in 1889. The product consists mostly of dimension and building stone. The quarry has a workable face of about three hundred feet and operates two channeling machines.

The following section, in descending series, was obtained here:—

Section.

	FEET	INCHES.
1. Stripping, clay and decomposing limestone.....	6	
2. Limestone, yellow to lavender, lithographic, concretions in places (has been used by lithographers).....	2	6
3. Limestone, dark gray, soft	1	6
4. Limestone, almost white, soft, weathers into two layers...	2	10
5. Limestone, dark gray, coarse grained, crystalline.....	2	
6. Limestone, dark gray, fine grained, in two layers.....	2	2
7. Limestone, dark gray, fine grained, chert concretions occasionally.....	4	
8. Limestone, mottled gray to brown, coarse grained, crystalline.....	1	
9. Limestone, brownish gray, soft, in two layers of equal thickness.....	4	
10. Limestone, gray, coarse grained.....	2	
Total thickness of rock.....	22	0

Location and
product.

Lauritzen, James (56):— Mr. Lauritzen's quarry is situated at Webster. The product consists of building and dimension stone, and macadam. The quarry is in the St. Louis Limestone.

The following section, in descending series, was obtained here:—

Section.

	FEET.	INCHES.
1. Stripping, soil, residuary clay and decomposing limestone	5	
2. Limestone, almost white, fine grained, crystalline, conspicuously cross bedded.....	5	
3. Limestone, dark gray, coarse grained, suture joints, chert concretions, in numerous layers.....	2	6
4. Limestone, drab, lithographic, in eight layers.....	3	9
5. Limestone, chocolate to gray, fine grained, fossiliferous.		9
6. Limestone, lavender, fine grained, chert concretions.....	1	
7. Limestone, lavender, fine grained, fossiliferous, in four layers	2	
8. Limestone, varying in color and texture, in layers one or two inches thick.....	3	
9. Limestone, lavender, fine grained, in layers from six to eight inches thick.....	2	6
Total thickness of rock.....	20	6

Munsen (52):—Mr. Munsén has a quarry in the immediate neighborhood of Mr. Doering's, with the same railway connection. The product consists of "furnace rock." The quarry was opened in 1880. Its face is about seven hundred and fifty feet long. The stone quarried is of St. Louis Limestone. Location and product.

The following section, in descending series, was obtained:—

	FEET. INCHES.		
1. Soil and residuary clay	5		
2. Limestone, decomposing.....	12		
3. Limestone, gray, fossiliferous, in several layers.....	5	10	
4. Limestone, buff, alternately fine and coarse grained, soft, fossiliferous	3		
5. Limestone, gray, crystalline.....	1	10	
6. Limestone, blue to yellowish, vary grained.....	3	9	
7. Limestone, gray, coarse grained, fossiliferous, in two layers.	1	4	
8. Limestone, gray, fine grained.....		9	
9. Limestone, gray, crystalline, fossiliferous, in three layers.		10	
10. Limestone, gray, fine grained, brittle, fossiliferous, small chert concretions near middle.....	4	10	
11. Limestone and shale in thin layers.....		8	
12. Limestone, gray, fine grained, numerous small concretions of chert.....	1	6	
13. Limestone, light gray, hard, siliceous.....		7	Section.
14. Limestone, light gray, soft.....	1	4	
15. Limestone, dark gray, lithographic.....		8	
16. Limestone and shale.....		8	
17. Limestone, grayish to brown, coarse grained, crystalline, three layers.....	3	5	
18. Limestone, lavender, fine grained, brittle.....	1	1	
19. Limestone in thin layers, with shale partings, gray to lavender, fine grained.....		10	
20. Limestone, dark gray, concretionary, in three layers.....	2	9	
21. Limestone, light lavender, fine grained, hard and brittle...			
22. Limestone, suture joints.....		3	
23. Limestone, light lavender, fine grained, hard and brittle, in three layers, respectively thirty, twenty-four and eight inches thick.....	4	6	
Total thickness of rock.....	52	5	

Shores Quarry Co. (54):—This quarry is situated on the Kirkwood Branch railway, five miles from Carondelet, in the St. Louis Limestone. It was opened March, 1889. The product consists of "furnace rock," paving, building and dimension stone. The quarry is an open cut in a hill-side. Location and product.

The following section, in descending series, was obtained here:—

	FEET. INCHES.	
	FEET.	INCHES.
1. Soil and residuary clay.....	4	
2. Limestone, decomposing	2	
3. Limestone, gray to brown, coarse grained.....	3	9
4. Limestone, lavender, lithographic, in three layers, the two lower of which are separated by a thin layer of shale....	8	2
5. Limestone, gray, coarse grained, crystalline.....	1	2
6. Limestone, lavender, lithographic, in four layers.....	8	
7. Limestone, gray, fine grained, chert concretions, several layers.	4	
8. Limestone, brownish, siliceous, chert concretions.....	1	6
9. Limestone, gray, crystalline, almost a solid mass of fossils.	1	4
10. Limestone, brownish to gray, coarse grained.....	1	8
11. Limestone, dark lavender, numerous chert concretions....		10
12. Limestone, light gray, lithographic, chert concretions....	1	8
13. Limestone, lavender, lithographic, calcite veins.....	1	3
14. Limestone, dark gray, rather coarse grained	1	
15. Limestone, mottled, vary grained, concretionary.....	2	3
16. Limestone, gray, crystalline, fine grained toward bottom..	3	7
17. Limestone, lavender, lithographic, in three layers.....	1	8
18. Limestone, yellow, shaly	1	6
19. Limestone, lavender, lithographic.....	1	1
20. Limestone, gray, fine grained, soft	1	2
21. Limestone, light gray, fine grained, weathers white.....	2	2
22. Limestone, drab and pinkish, lithographic	1	8
Total thickness of rock.....	46	5

Location and product.

Theby, Michael (48):— Mr. Theby has a quarry which is situated on the west of South Broadway, near the river Des Peres, in the St. Louis Limestone. The product consists mostly of “furnace rock,” which is sold to iron furnaces for fluxing purposes; but a small amount is used as macadam, building stone, and dimension stone. The quarry is in a bluff, and has about one hundred yards of workable face. No machinery is used.

The following section in descending series was obtained here:—

	FEET INCHES.	
	FEET.	INCHES.
1. Loess and residuary clay.....	16	
2. Limestone, much decomposed.....	4	
3. Limestone, drab, coarsely crystalline in two layers of equal thickness.....	4	8
4. Limestone, grayish, coarsely crystalline in three layers....	1	10

Section.

	FEET. INCHES.		
5. Limestone, gray, drab, compact, brittle, splintery fracture suture joints, fossiliferous, in two layers.....	3	3	
6. Limestone, buff to bluish, in beds two to six inches thick...	3		
7. Limestone, lavender, lithographic.....	1		
8. Limestone, lavender, grading to buff towards the bottom, harder and finer grained towards the top.....	2	1	
9. Limestone, buff, rather fine grained, calcite veins, in layers varying from three to eighteen inches in thickness.....	5		Section.
10. Limestone, mottled buff and bluish, blotches of calcite, very fossiliferous.....		3	
11. Limestone, mottled buff and bluish, blotches of calcite, suture joints.....	2	8	
12. Limestone, lavender, compact, siliceous.....	1	6	
Total thickness of rock.....	29	3	

Zeiss, Henry (49): — Two quarries belonging respectively to Mrs. James Zeiss and to Henry Zeiss, are at present worked as one quarry. They adjoin each other in the bluff of St. Louis Limestone, in the neighborhood of Mr. Theby's quarry, mentioned above. There is about two hundred and fifty yards of workable face to the quarry. It was opened in 1872. The product consists of macadam, dimension stone, "furnace rock," etc.

The following section, in descending series, was obtained:—

	FEET. INCHES.		
1. Loess	6		
2. Limestone, decomposing, and residuary clay.....	10		
3. Limestone, lavender, with mottled appearance, vary grained, calcite blotches at bottom, very fossiliferous	2	4	Section.
4. Limestone corresponding to numbers 3, 4, 5 and 6 of the Theby section as given above.....	12	9	
Total thickness of rock.....	25	1	

The beds here dip slightly in a southerly direction.

Watson Construction Company (65): — This company has a quarry which is situated in the bluffs of the Missouri river, at Vigus Station. The stone quarried is probably St. Louis Limestone. The quarry is connected with the St. Louis, Kansas City & Colorado railway. Stone is swung from the quarry by derricks directly to the freight cars. The product is mostly riprap.

The following section,* in descending series, was obtained here:—

	FEET. INCHES.	
1. Soil and Loess	9-11	
2. Residuary clay....	4-5	
3. Limestone, partially decomposed.....	4-5	
4. Limestone, drab, fine grained, hard, brittle, conchoidal fracture, in thin layers, one to three inches thick...	2	6
5. Limestone, like No. 4, but coarser grained and has calcite veins.....		8
Section. 6. Limestone, drab, coarse grained, brittle, sub-conchoidal fracture, suture joints, specked with calcite and chert, occasional chert concretions, quarries as one bed in some places, but in others it splits into two beds...	9	10
7. Limestone, like No. 6, but contains pyrite crystals.....		8
8. Limestone, gray, coarse grained, many calcite blotches	1	1
9. Limestone, like No. 8, but in layers three or four inches thick.....	2	
10. Limestone, gray, coarse grained, specked with calcite, very fossiliferous, often quarries in solid blocks, but in places splits into many beds.....	4	5
11. Limestone, in heavy beds, much weathered, and covered mostly with talus.....	10	
Total thickness of rock.....	27	7

* The same section is exposed at the Crystal Spring quarry.

STATISTICAL TABLES.

The figures, which are given below, of the production of stone quarries, although not complete, are as nearly so as they could be made under the circumstances which governed their collection. Source of statistics. Many of the small producers of stone keep no books, and have scarcely any idea of what their annual output amounts to. Others who had the desired figures were unwilling to give them to one who had not the authority to demand them. In some of such cases estimates have been made by the author which are based upon the fragments of information gathered about the stone quarries. Where this was not feasible figures are omitted altogether. Omissions. Figures estimated by the author are marked by an asterisk. The figures which are omitted would not, probably, affect the total result to any considerable extent.

The totals given are undoubtedly below those for an average year, because of the labor strikes which injured the quarry business noticeably during 1889. It is claimed by one of the largest contractors and producers in St. Louis that in 1889 the production of stone in the neighborhood of St. Louis was at least thirty per cent. below the normal amount. Production below the average.

The production is given by different quarrymen in many different terms, but for the purpose of the writer, the figures of production obtained have been reduced to those terms which are most commonly used. These terms are perches, squares and cubic feet.

Where values were not obtainable with the amounts of production, they have been filled out by the use of the average market prices for 1889, determined from the figures which were obtained elsewhere.

In the class of rubble, riprap and spall, used for ballast and such purposes, is included the class of stone, called, "furnace rock" which is sold to the iron furnace companies to be used as a flux. Furnace rock.

The heading "Building Stone" in the table is the term used Building stone. locally for foundation material, and it is here applied with that local meaning.

STATISTICS OF THE STONE QUARRIES OF ST. LOUIS CITY AND COUNTY FOR THE YEAR 1889.

THIS LIST DOES NOT INCLUDE LIME PRODUCING QUARRIES.

The location of quarries may be found upon one of the maps accompanying
this article by their respective coördinates, or numbers.

Position on Map.	PROPRIETOR.	No. Squares of Macadam Produced.	No. Perches of Building Stone Pro- duced.	No. Squares of Paving Produced.	No. Perches of Spall, Rip- rap, Rubble Produced.	No. Cubic Ft. of Dimen- sion Stone Produced.	Value of Total Product.
L, 17	Jno. C. Lohrum.....	2,000	5,000	300	800	1,500	\$19,975
L, 17	Frank Albernaclus.....	350		75		500	2,075
L, 17	Adam Kern.....						
I, 20	Krug & Zesch.....	1,075	8,316	177	780	4,598	12,649
I, 20	G. Eyermann (estate).....	300*	4,839	350*			7,258
I, 20	J. Friederichs.....						
I, 20	Conrad Kempf.....	60	4,580			2,000	7,862
I, 20	Henry Baldwin.....	15	3,200			900	5,500
L, 17	Martin Lorenz.....	300*	4,842				8,313
G, 6	Stiefel & Ruckert.....						
G, 6	Wm. Wleman.....		200				300
N, 9 (2 quar's)	Bambrick-Bates.....	500*	25,000*	2,000*	10,000*	3,000*	55,000*
O, 10	Heman Bros.....	2,000*	6,000*		1,000	1,000	16,000
K, 7	Klinealy & Sons.....						
G, 7	Devereux & Sons (F, 12-19) (K, 9-12)	575	1,500				8,500
F, 17, F, 12-K, 9	J. B. O'Meara.....	5,574	11,993	1,156	1,000	34,200	73,806
D, 7	G. E. Prendergast.....						
J, 12	Wm. H. Barnett.....	1,200		200	1,300	15,000	21,600
J, 10	T. E. Cavanaugh.....	3,500	4,000	700			27,300
J, 9	Hogan & Moran.....	5,000	7,000	800	1,000		32,020
I, 13, -H, 12, - C, 14 (8 quar's)	Fruin, Bambrick & Co.....	8,205	19,792	1,308	1,030		69,090
C, 14	H. Brocksmith.....	100	1,200	200			4,025
M, 15	Stiefel & Ruckert.....	4,500	100	250			19,400
M, 15	A. O. Englemann.....	1,000*	3,500	550	1,500	2,000	15,250
K, 19	"Work House".....	9,030			7,779		43,053
H, 13	Watson Const. Co.....				375		407
I, 13	Christian Pieper.....	300	1,000				2,800
I, 13	Patrick Mohun.....						
I, 13	St. Louis Stonemasons.....						
I, 13	G. Eyermann (estate).....	5,000	1,500	300		2,000	26,800
I, 13	Conrad Pickel.....	400	3,000				6,200
J, 10	Thos. Byrnes.....	100	300				875
J, 7	J. E. Perkinson & Bro.....	4,000		500	4,000	3,000	14,700
K, 6	E. W. Hogan.....	6,900	12,000	830			54,975
L, 7	Redemayer.....						
L, 7	M. Hogan.....	900					3,825
K, 19	Louis Grund.....	300	3,273	200	100		6,809
J, 19	E. Allen.....	20	800			500	1,550
J, 19	Knauss & Willis.....		2,000			1,000	3,400
47	Crystal Spring Co.....				3,450	10,000	8,000
48	Michael Theby.....	100	600		200	200	1,355
49	Henry & Mrs. Zeiss.....	400	1,200		1,200	4,500	5,310
50	Boem.....						
51	J. H. Doering.....		1,000*		12,000	5,000	10,140
52	Munsen.....				30,000		15,000
53	P. Fabrick & Marshall.....						
54	Shores Quarry Co.....		800	850	10,000	450	14,117
55	Glendale Quarry Co.....	100			11,000	13,000	22,485
56	Jas. Lauritzen.....	200	700				1,120
57	Eureka Quarry Co.....	100*	300*				875
58	Thos. Madden.....						
59	Andrew Pope.....						
60	Henry Siefert.....						
61	Jno. C. Steffen.....					3,000	800
62	Jno. Exner.....	200*	3,240	100*			5,213
63	Jefferson Barracks.....		2,000*				3,000
64	Bessen & Sons.....				4,000	12,000	3,870
65	Watson Construc. Co.....				8,200		4,000
66	Jno. Schwenn.....	95	300				850
67	Dore & Wallace.....						
68	Andrew.....						
	Totals.....	64,399	139,505	10,466	110,414	119,348	\$861,351

* Estimated.

The figures given in the above table include only 54 of the 69 active quarries.

THE LIME INDUSTRY.

GENERAL REMARKS.

A large portion of the lime which is consumed and sold in St. Louis is produced in distant portions of the State. There are a number of "active" lime kilns in St. Louis county, but none at present within the city limits. Stone from the St. Louis, Keokuk, Burlington and Trenton formations has been burned, to some extent, but the Trenton rocks seem to have given the most satisfaction, and are now most extensively used. The Burlington formations, where accessible, furnish perhaps the best quality of limestone, but the limestone beds are so intimately mixed with layers and concretions of chert, that the sorting of the materials has proved too great an expense for the extensive use of these beds.

Formations furnishing lime.

ANALYSES OF LIMESTONE.

For the purpose of determining the value of the local materials for the manufacture of cement and lime, a large number of samples of limestone have been analyzed. Wherever a formation is now being quarried for the manufacture of lime, there, samples of stone were collected. The analyses were made with two specific objects in view. The first was a determination of the absolute value of the rock; the second was the establishment of a standard for comparison with the collections from horizons which are not worked for lime production.

Objects of analyses.

The St. Louis Limestone, within the city limits, is not at present used for lime making. Were the fact established that beds of the requisite quality for this purpose existed within these limits, these beds could be used to great advantage, first, because of their proximity to the local market, and, secondly, because great quantities of waste rock at the numerous quarries could be utilized. Hence, for the purpose of collecting a complete series of samples, a section was selected in this formation

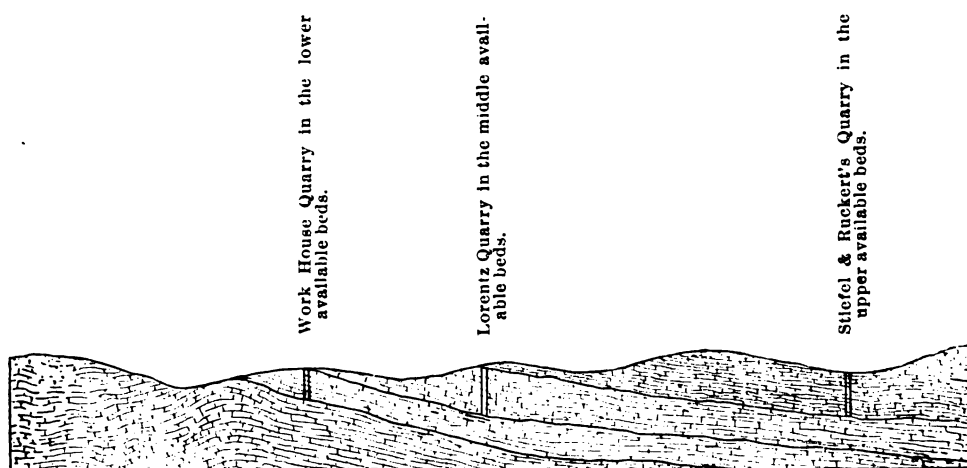
No. lime kilns in city limits.

Typical section
chosen.

Results to be
reached.

which should represent as nearly as possible all of the different beds which could be made available. This section of the St. Louis Limestone was constructed from measurements made at three quarries along the Mississippi river. Going south each section is thought to be approximately a continuation of the preceding one. That at the Stiefel and Ruckert quarry represents the higher part of the formation, that at Martin Lorentz', the next lower, and that at the Work House quarry, the lowest available part. At the outset it was hoped that sufficient analytical work could be done to determine whether the qualities of the various beds were persistent throughout their extent; but, owing to a considerable dip of these beds a much larger section was found than had been anticipated, and, consequently, the number of analyses to be made grew so large as to make this attempt impracticable, at least, for the time being. The results of the analyses can, therefore, be applied with exactness only to those outcrops from which the samples were actually taken; they only suggest what may be expected in other portions of the beds they represent.

The following conventional cross section, running a little west of south, will illustrate the conditions of occurrence and the interpreted relations of the sections:



Diagrammatic cross section in the St. Louis Limestone, indicating the relative position of the rocks in the quarries where the beds were sampled for analysis. Looking west.

The samples for the analyses given in the following tables were collected mostly from active stone quarries. They were taken so as to represent as nearly as possible an average of the beds, vertically and laterally, in the immediate vicinity of the section. In addition to such samples collections were made from different geological formations as follows:—

From the Keokuk Limestone at the second tunnel of the Missouri Pacific railway, the sample for analysis No. 64 was taken as an average of the exposed strata, which amount to about thirty feet in thickness.

From the Burlington Limestone near Valley Park, an average sample of the beds was taken for analysis No. 66, at an old quarry which was formerly worked for lime production, and near which an old kiln is still standing. The abundance of chert in the beds has caused the abandonment of work.

From the heavy beds of the First Magnesian Limestone, near Glencoe, an average sample was taken for analysis No. 77.

In the following tables of analyses reference is made under each title to the page where the section is described from which samples were collected; further the stratum number is given with each analysis number. In the descriptions of sections thus referred to, analyses numbers accompanying the respective strata, again refer back to the tables of analyses.

ANALYSES OF LIMESTONES FROM ST. LOUIS CITY AND COUNTY.

In the following table of analyses the term "insoluble silicious residue" means that portion of the limestone which is insoluble in dilute Hydric Chloride (1 to 3), exclusive of organic matter. The existence of the latter was recognized in all samples, but it was burned off before weighing. These residues consist for the most part, of clear transparent quartz; but, with the higher percentages of "insoluble residue," some clay and other insoluble matter is presumably present. The term "combined oxides" is meant to include alumina and ferric oxide which were weighed together. The lime and magnesia found by analysis were calculated as carbonates and are so tabulated. The percentages are of samples dried at 100° C. Percentages marked with an asterisk (*) were determined by difference.

A. E. WOODWARD.

Samples Nos. 1 to 60 inclusive are of successive beds of the St. Louis Limestone, taken in a descending order.

STIEFEL & RUCKERT'S QUARRY, St. Louis Limestone.

(For description of section see p. 61.)

Analysis Number.	Strat- um No.	Insoluble Siliceous Resi- due.	Combined Oxides.	Calcium Carbonate.	Magnesium Carbonate.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
1	3	3.39	0.99	78.98	14.12
2	4	9.00	0.83	83.53	3.91
3	5	2.24	0.35	91.83	4.20
4	6	1.20	0.16	96.02	0.72
5	7	1.53	0.25	96.34	0.86
6	8	1.40	0.25	96.65	0.76
7	9	3.57	0.31	93.73	0.86
8	10	3.41	0.27	94.00	0.76
9	12	18.70	4.24	45.00	31.51
10	13	8.56	0.95	72.05	17.29
11	14	1.83	0.32	89.80	5.90
12	15	2.57	0.35	96.40	0.50
13	16	0.76	0.17	97.36	0.58
14	18	12.73	3.84	56.10	26.69
15	19	3.35	0.85	71.52	20.03
16	20	5.36	0.52	87.10	7.02*
17	21	4.71	0.22	94.15	1.48
18	22	2.47	0.31	92.30	1.88
19	23	4.05*	0.30	92.55	3.10

MARTIN LORENTZ' QUARRY, St. Louis Limestone.

(For Description of Section, see p. 54.)

Analysis Number.	Strat- um No.	Insoluble Siliceous Resi- due.	Combined Oxides.	Calcium Carbonate.	Magnesium Carbonate.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
20	3	6.53	0.83	83.85	8.16
21	4	8.02	1.01	79.40	10.81
22	5	9.97	1.07	70.80	10.86
23	6	3.44	0.37	92.05	3.67
24	7	4.61	0.34	93.85	0.99
25	8	6.08	0.61	78.15	15.81
26	9	11.63	3.10	52.85	29.25
27	10	2.83	0.19	94.75	0.97
28	11	6.79	0.55	90.55	1.06
29	12	8.77	1.35	56.45	31.95
30	13	7.64	0.80	84.75	5.27
31	15	11.02	2.50	57.80	26.33
32	16	6.29	0.95	84.95	5.98
33	17	1.97	0.35	87.60	8.66
34	18	10.40	11.75	63.30	17.22
35	19	3.20	0.40	93.20	1.44
36	20	19.96	4.80	51.60	19.22
37	21	2.32	0.26	94.35	1.70
38	22	1.64	0.25	95.70	1.10
39	23	5.77	0.43	89.95	2.23
40	24	2.84	0.25	93.60	2.23
41	25	2.72	0.35	93.75	2.38
42	26	2.77	0.40	92.40	3.22

WORK HOUSE QUARRY, St. Louis Limestone.

(For Description of Section, see p. 63.)

Analysis Number.	Strat- um No.	Insoluble Siliceous Resi- due.	Combined Oxides.	Calcium Carbonate.	Magnesium Carbonate.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
43	2	4.05	0.37	93.21	0.79
44	3	10.05	1.78	80.12	5.49
45	4	9.56	1.82	61.89	24.53
46	5	6.51	0.78	80.49	10.45
47	6	9.17	0.78	74.79	11.10
48	7	2.17	0.35	89.94	1.61
49	8	3.88	0.67	73.49	19.93
50	9	2.86	0.35	89.26	4.73
51	10	1.85	0.28	94.84	1.38
52	11	3.19	0.55	85.62	9.20
53	12	1.10	0.30	96.15	0.59
54	13	2.26	0.42	94.97	0.94
55	14	5.76	0.52	92.21	0.73
56	15	9.22	0.65	82.05	7.87
57	16	6.66	0.66	88.87	3.12
58	18	1.48	0.35	94.03	2.33
59	20	2.40	0.53	78.97	13.36
60	21	1.07	0.31	93.25	4.30

Analyses.

CHAS. W. GOETZ' QUARRY, St. Louis Limestone.

(For Description of Section at Barthold Valley, see p. 82.)

61	2	2.00	0.61	*96.81	0.58
62	3	0.70	0.27	*98.41	0.62
63	4	1.24	0.37	*97.71	0.68

RAILWAY CUT, 2D TUNNEL, Keokuk Limestone.

64		4.35	1.75	77.95	14.84
----	--	------	------	-------	-------

CRYSTAL SPRING QUARRY, VIGUS STATION, St. Louis Limestone.

(For Description of Section, see p. 70.)

65		2.00	0.40	95.15	0.64
----	--	------	------	-------	------

RAILWAY CUT, VALLEY PARK, Burlington Limestone.

(See p. 75.)

66		1.10	0.40	94.00	3.18
----	--	------	------	-------	------

HERBERT DORENHEIM'S QUARRY, ST. PAUL, Trenton Limestone.

(See p. 80.)

Analysis Number.	Stratum No.	Insoluble Siliceous Residue.	Combined Oxides.	Calcium Carbonate.	Magnesium Carbonate.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
67		0.85	0.85	97.75	0.45

THORN AND HUNKINS' QUARRY, MINCK STATION, Trenton Limestone.

(See p. 83.)

68		12.15	0.45	86.00	0.46
----	--	-------	------	-------	------

GLENCOE COMPANY'S SOUTH QUARRY, GLENCOE, Trenton Limestone.

(For Description of Section, see p. 81.)

69		2.25	0.80	89.40	6.96
----	--	------	------	-------	------

GLENCOE COMPANY'S MIDDLE QUARRY, GLENCOE, Trenton Limestone.

(See p. 81.)

70		0.45	0.65	97.20	0.46
----	--	------	------	-------	------

GLENCOE COMPANY'S NORTH QUARRY, GLENCOE, Trenton Limestone.

(For Description of Section, see p. 82.)

71	2	6.00	1.05	82.55	9.27
72	3	1.00	0.55	96.40	0.42
73	4	0.46	0.40	*98.60	0.34
74	5	0.70	0.25	97.40	0.42
75	6	0.35	0.30	97.75	0.27
76	7	0.55	0.60	96.75	0.27

RAILWAY CUT, GLENCOE, First Magnesian Limestone.

77		12.35	1.10	48.75	87.09
----	--	-------	------	-------	-------

While not attempting here an exhaustive discussion of the results contained in the preceding tables, a brief reference will be in place to some of the more salient features developed. An analysis of the contents of these tables results in the following classification:—

Total number of analyses.....	77
Number of samples of stone not at present used for lime production.....	65
Number of samples from St. Louis city	60
“ “ “ “ county.....	17
Number of samples from the St. Louis Limestone.....	64
(Three of these are from beds at present used.)	

Number of samples from the Keokuk Limestone.....	1
<i>(An average of all the beds exposed.)</i>	
Number of samples from the Burlington Limestone	1
<i>(An average of the beds formerly used.)</i>	
Number of samples from the Trenton Limestone.....	10
<i>(Nine of these are of beds now used.)</i>	
Number of samples from the First Magnesian Limestone.....	1
<i>(An average of beds aggregating about 30 ft. in thickness.)</i>	

The limestones used commercially for the manufacture of lime rarely contain less than eighty-nine per cent. of calcium carbonate. Applying this fact here, we are able to separate those limestones which are probably of value for this purpose, from those which are not, at least so far as the lime contents is concerned. Of the analyses of the twelve beds or series of beds which lime producers are now using there is but one the results of which show the amount of impurity to exceed ten per cent., and in that case the excess is only a fraction of one per cent. To be compared favorably with these twelve, there are of the remaining sixty-five limestone samples, thirty-four in which the amount of calcium carbonate is above eighty-nine per cent. The beds represented by these thirty-four are those of Valley Park and Vigus Station, twelve at the Stiefel & Ruckert quarry, eleven at Martin Lorentz' quarry, and nine at the Work House quarry.

The beds at Valley Park seem to be rendered useless by the immense amount of chert which they contain. At Vigus Station the six successive beds (which are quarried for building stone) were sampled at the Crystal Spring quarry. They have a total thickness of a little over fifteen feet, and would be available for the manufacture of lime. At the Stiefel & Ruckert quarry the twelve beds, Nos. 5 to 10, 14 to 16 and 21 to 23, have a total thickness of $36\frac{1}{2}$ ft., and they occur in one group of six beds, and two groups of three beds each. The total thickness of the group of six beds is $16\frac{1}{2}$ ft. At Martin Lorentz' quarry the eleven beds, Nos. 6, 7, 10, 11, 19 and 21 to 26, have a total thickness of $26\frac{1}{2}$ ft., and six of these having a total thickness of $15\frac{1}{4}$ ft. are successive beds. At the Work House quarry the nine beds, Nos. 2, 7, 9, 10, 12, 13, 14, 18, 21 are somewhat separated, but six of them have a total thickness of $25\frac{1}{4}$ ft., and are separated

Limestone with 89
per cent. of lime.

Distribution of
lime beds.

by only two beds, of inferior quality, which have a total thickness of $4\frac{1}{2}$ feet. The total thickness of the nine beds is 39 feet.

Final results postponed.

The final settlement of the question of the adaptabilities of these limestones is, however, left for future investigation and experiment. Some of the limestones are remarkably pure and are worthy of being experimented with, in connection with some of the neighboring clays, for the production of hydraulic cement.

A DESCRIPTIVE LIST OF LIME WORKS.

The following descriptions include only the works of producers which are situated within the county or city of St. Louis; some of the firms mentioned have extensive works in other parts of the State.

Dorenheim, Herbert (76):—Mr. Dorenheim began producing lime with one kiln, at St. Paul, in May, 1890. Since that time he has produced about six thousand bushels per month.

Product.

The stone, which burns to a black lime, is taken from the quarry of the old firm of Goetz & Cobb, which now has here (owing to some litigation) three idle kilns.

Formation.

The formation quarried is Trenton Limestone, and the sample for analysis number 67, was taken as an average of the beds used for lime making.

Location.

Glencoe Lime and Cement Company (70 to 72):—This company has two sets of works at present operating, which are located respectively about two and four miles north-west of Glencoe. Both are connected with the main line of the Missouri Pacific railway by a branch track.

Character of product.

Two kinds of lime, known as white and black lime, are produced. The former is a finishing lime and commands a high price, but has a comparatively small sale. The latter is used for many purposes, and constitutes the bulk of the product, selling at a much lower price than the white lime. The two varieties differ very much in character; the black lime being said to slack slowly and coolly, and to set rapidly, while the white lime acts in an opposite way.

Trenton stone.

All of the limestone used at both places comes from the Trenton formation. At the works nearest Glencoe there are two

quarries and two kilns.* One of the quarries, which we term *Product*, the southern one, furnishes a stone which burns to a white lime.

Following is a section at this quarry in descending series. Analysis No. 69 is of an average sample of all the beds:—

	FEET. INCHES.	
1. Slope of stripping.....		
2. Limestone, gray to lavender, fossiliferous, vary-grained, vermiform cavities, very cherty.....	5	
3. Like No. 2, but more cavities.....	3	9
4. Limestone, brown, very cherty, coarse grained, fossiliferous, vermiform cavities.	3	
5. Limestone, brown to gray, granular.....		2-4
6. Limestone, thin beds, gray to lavender, fossiliferous, coarse grained vermiform cavities.....	3	
7. Like No. 6, but finer grained.....		4
8. Like No. 6, but vary-grained.....	4	4 Section.
9. Limestone, brown, granular, fossiliferous.....		2
10. Slaty shale, fossiliferous.....		$\frac{1}{2}$ - $\frac{1}{2}$
11. Limestone, lavender, vary grained, fine to very coarse.....		8
12. Shale.....		$\frac{1}{2}$
13. Limestone, gray and brown, vermiform structure in grain, very fossiliferous.....	2	1
14. Same as No. 13, but less fossiliferous.....	3	
Total thickness of rock.....	25	8

About an eighth of a mile north of this quarry a new quarry has been recently opened, from which a stone is taken which burns to a black lime. The opening is not yet sufficiently de-*Product*veloped to expose a good section. The rock is very fossiliferous, semi-crystalline, and colored light and dark gray. An average sample of this rock was used for analysis No. 70.

At the works, about four miles north-east of Glencoe, are the two "north" quarries and three kilns. The quarries are higher stratigraphically and topographically than those described above. The stone taken from them burns to a black lime.

The following section, in descending series, was made at these quarries. Numbers 4, 5 and 6 are but imperfectly separated.

* Some of the beds here will furnish a good dimension stone, while some that would appear to do so are worthless for that purpose because of their tendency to weather into a honey-comb condition, as previously described.

		FEET. INCHES.	
Section.	1. Slope of stripping.....		
	2. Limestone (analysis No. 71), decomposing and clayey..	3	
	3. Limestone (analysis No. 72), gray turning to almost black towards top, irregular chert layer, sub-crystal- line, fine grained, hard, fossiliferous.....	1	2
	4. Limestone (analysis No. 73), bluish, mostly fine grained but coarse in patches, sub-crystalline, calcite blotches, hard, suture joints, splintery fracture.....	1	1
	5. Limestone (analysis No. 74), gray, soft at base but harder toward top, fine grained	7	4
	6. Limestone (analysis No. 75), light gray, highly fossil- iferous, semi-crystalline, coarse grained, irregular fracture, suture joints, cherty in places.....	6	9
	7. Limestone (analysis No. 76), dark gray, ferruginous bands, extremely fossiliferous, soft, granular, coarse grained....	7	
	Total thickness of rock.....	26	4

Mode of quarrying In each of these quarries the rock is dislodged from the face of the quarry, and more or less shattered by powder blasts. It is then broken into quite small pieces by the use of hammers, and hauled in carts up an inclined plane, whence it is dumped into the kilns to be burned. After the burning it is shoveled directly into freight cars.

Product. *Goetz, Charles W.* (73 and 75): — Mr. Goetz has lime works at Bartholds valley, and at a point on the county line near Port Royal. At the former place there are two kilns and three quarries, only one of which is, however, at present worked. A high grade of white finishing lime is produced. The section here, presumably in St. Louis Limestone, is as follows, in descending series: —

		FEET. INCHES.	
Section.	1. Stripping.....	10	
	2. Limestone (analysis No. 61), dark gray, fine grained, hard	4	8
	3. Limestone (analysis No. 62), light gray, fine grained, soft, fossiliferous.....	3	
	4. Limestone (analysis No. 63). Like No. 3 but harder.....	5	
Total thickness of rock.....		12	8

The works at Port Royal have been only recently started. Stone from the Trenton horizon is to be used, and two kilns are in the process of construction.

Thorn and Hunkins (74): — This firm has its works located at Minck, on the "Frisco" railroad, just across the Meramec river from St. Paul. One kiln is use, and stone is procured from two quarries, in the Trenton Limestone, which are situated at different elevations in an old bluff of the river. The formation is characteristically Trenton. The sample for analysis No. 68 was taken as an average of the beds here quarried which represent a total thickness of about thirty feet.

STATISTICAL TABLES.

The facts given in the following table are the results of personal inquiry of the proprietors of the works. The production of lime in the vicinity of St. Louis has much increased since 1889, and the totals given below will probably fall far short of the figures for the present year.

STATISTICAL TABLE OF THE LIME PRODUCING WORKS IN ST. LOUIS COUNTY WITH STATISTICS FOR THE YEAR 1889.

The location of the works may be found on the County Map, accompanying this article, by their respective numbers.

Map Number.	Proprietor.	Location.	No. of Kilns.	No. of Quarries.	Production in Bushels.	Value of Product at Kiln.
70	Glencoe Lime and Cement Co	About 2½ miles N. of Glencoe	3	2	400,000	\$60,000
71	Glencoe Lime and Cement Co	About 4 miles N. of Glencoe	2	3		
72	Glencoe Lime and Cement Co	St. Paul	3	1	Not operating	in 1889.
	(In Litigation.)					
73	Chas. W. Goetz . .	Barthold's Valley .	2	3	75,000	30,000
74	Thorne & Hawkins	Minck	1	2	87,000	13,000
75	Chas. W. Goetz . .	On county line at Port Royal	2	1	Not operating	in 1889.
76	* Herbert Dorenhelm	St. Paul	1	1	Not operating	in 1889.
	Totals		14	13	562,000	\$103,000

* Produces now about 6,000 bushels per month.

THE SAND AND GRAVEL INDUSTRY.

GENERAL REMARKS.

Source of sand
and gravel.

The great mass of sand and gravel which is consumed in St. Louis comes from the Meramec river. A smaller amount is taken from the Mississippi river, and, comparatively, a very little from gravel deposits in the northern part of the city, which seem to belong, geologically, to the assorted drift of the glacial period. Red and gray gravel are shipped to St. Louis from Robertsville and other points in Franklin county.

The sand from the Meramec river is superior in quality to that from the Mississippi, which contains black, probably carbonaceous particles, which are said to "pop" in pointing. It is rather coarse and the grains are somewhat rounded.

A DESCRIPTIVE LIST OF SAND AND GRAVEL WORKS.

St. Louis Dredging Co.:—This company was organized in 1883, with a capital stock of \$50,000. It furnishes all the sand and gravel to the following companies, viz.: Griffith & Adams Sand and Gravel Transit Co., The New Missouri Sand Co., New St. Louis Sand Co., and the Eagle Sand Co.

In 1889 it sold 117,048 loads of sand and gravel, at an average price of 60 cents per load at the boat. A few barges full have been taken to the Illinois side.

The Eagle Sand Co.:—Previous to March this company did its own dredging. In 1889 it sold about 6,000 loads.

The Griffith & Adams Co.:—This company was organized in 1874, with a capital stock of \$12,000. Its sand is obtained from the area in the Mississippi river between the Eads and Merchants bridges.

THE MINERAL WATERS

OF

Henry, St. Clair, Johnson and Benton Counties.

BY

A. E. WOODWARD, ASSISTANT GEOLOGIST.

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PREFATORY REMARKS.

This report upon the mineral waters of Henry and adjoining counties is the result of field work done during last April and May. The report was ready for publication during the early summer, but has been withheld pending the preparation of the accompanying report on the St. Louis clay and stone industry. Since this time the work has been extended into many counties and the final report on the mineral waters of the State can probably be issued next year.

ARTHUR WINSLOW,
State geologist.

INTRODUCTION.

Scope of article.

The following article includes a description of the important springs and wells of Henry, St. Clair, Johnson and Benton counties, together with the results of analyses of their waters, made in the laboratory at Jefferson City. These waters may be grouped as follows:—

Characteristics.

1. *Alkaline and Alkaline Chalybeated Springs*: These are non-thermal springs containing small quantities of the carbonates of the alkalies and of the alkali earths in solution. Many of this class of waters contain, besides, noticeable quantities of iron carbonate, and where this is the case the water is known as chalybeate or iron water.

Distribution.

Representatives of the alkaline and alkaline chalybeate springs are found at "Windsor Spring" and Sand Creek Spring in Henry county, and at Pertle, Reed and Electric Springs in Johnson county.

Iron contents.

The principal ingredient of the alkaline waters here considered is calcium carbonate (or bicarbonate); with this occur carbonates of magnesia and of the alkalies together with some alkaline sulphates. As previously mentioned iron is present in many of these waters, from which it is deposited as the brownish red hydrate along the courses of the stream, or in any vessel in which the water is exposed to the air. Hence any beneficial effects which may result from the iron contents of these waters will be diminished by exposure of the water to the air, and the effects will be greatest when the waters are taken fresh from the springs.

2. *Alkaline Saline Springs*: These are represented by the artesian wells at Clinton, Henry county; Monegaw springs at Monegaw, St. Clair county; and Boling spring in Benton county. With these may also be classed the small undeveloped and unused spring north of Warrensburg in Johnson county, known as the "Sulphur spring," and also the well at Montrose, Henry county. With the exception of the latter, these alkaline-saline waters are characterized by the presence of chlorides of the alkalis together with the carbonates and sulphates of lime and magnesia. The Montrose water contains sulphates instead of chlorides and carbonates. All of the alkaline-saline waters excepting the Montrose water contain hydrogen sulphide gas and are termed "sulphur waters."

The origin of these two classes of waters cannot be definitely stated at present; but the differences already determined to exist between them offer suggestions in this direction.

First, by reference to the following table it will be seen that the temperatures of the waters of the same class do not vary much and further that the alkaline waters are invariably colder than the alkaline-saline waters. This indicates, at least, similarity in conditions of origin of the waters of the same class, and difference in conditions of origin between waters of the different classes.

Temperature in Degrees, Fahrenheit.	Alkaline-Saline, Muriated.					Alk.-Saline, Sulphated.	Alkaline.				
	Boling Spring, Benton Co.	Monegaw Spring, St. Clair Co.	Sulphur Spring, N. of Warrensburg, Johnson Co.	Clinton Artesian Well, Henry Co.	Water Works Well, Henry Co.	Ford Well, Montrose, Henry Co.	Sand Cr.'k. Spring, Henry Co.	Windsor Spring, Henry Co.	Reed's Spring, Johnson Co.	Electric Spring, Warrensburg, Johnson Co.	Pertie Spring, Warrensburg, Johnson Co.
Temp. air....	57°	59°	59°	68°	68°	48°	65°	74°	54°	70°	72°
" water.	58°	61°	56°	58°	56°	49°	49°	47°	52°	51°	52°
Av. of water.	57.8°					49°	50.2°				
	Accompanied by Sulphu- retted Hydrogen and free Carbonic Acid.					Not accompanied by Sulphuretted Hy- drogen.	With free Carbonic Acid.				

Differences in
composition.

Subterranean
flow of water.

Alkaline waters,
shallow source.
Alkaline-saline
a deep source.

Explanation of
Analyses.

Second, the distinguishing constituents of the alkaline waters are carbonates of lime and of iron; those of the alkaline-saline waters are hydrogen sulphide gas and chloride of sodium. Now, all natural waters which flow from the ground, either from springs or from wells, have passed through various rocks. The waters may pass through these rocks either by a slow process of percolation or may flow through them along joints, cracks or fissures, or the two processes may be combined. The waters may seep through rocks which lie near the surface and flow out at the face of the rock within a short distance, or they may sink to great depths and reach the surface only through a long natural or artificial opening. All waters of surface springs and most waters from deep sources were originally derived from the rain-fall. As the rain water soaks through the rocks it dissolves out various constituents in amounts proportional to their solubilities and to the length of time the water is able to act on them. Rocks near the surface suffer most from this solvent action of rain water and any very soluble constituent will be removed in a comparatively short time. The flow of water at great depths is, on the contrary, more sluggish and the soluble materials endure longer. The alkaline waters here referred to contain in solution, such materials as could be supplied from the rocks which we find at the surface, and are further, frequently seen to issue directly from these rocks. The alkaline-saline waters, on the contrary, are seldom seen to issue directly from surface rocks, and they further contain an extremely soluble substance, chloride of sodium (common salt), which we do not recognize in the surface rocks, and which, by the above reasoning, would not probably exist there at this date. Hence we have reason to assign to the alkaline waters a shallow source, and to the alkaline-saline springs a deep source.

The analyses of the waters have been expressed in terms of the compounds probably present. In the analyses of the alkaline-saline water, the carbonate of lime given in the table is the amount of lime actually precipitated on boiling away the free carbonic acid. In other cases the usual method of combining the acids and bases actually found, has been employed. Thus

in the alkaline waters chlorine is combined with the bases in the order potash and soda; sulphuric anhydride with the bases in the order potash, soda, magnesia, lime; the remainder of the bases have been combined with carbonic anhydride as neutral carbonates. The amount of carbonic anhydride required for this, subtracted from the amount actually found by analysis, yielded an amount assumed to be either free or combined with the carbonates of lime, magnesia, and iron to form bicarbonates. In this way results are obtained which are readily comparable with each other and with other analyses; but the extent to which they express the actual combinations is subject to the inaccuracies inherent in the method.

Explanation of
analyses.

In the present condition of knowledge of the therapeutic value of the mineral constituents of waters, no definite conclusion can be offered from a consideration of these analyses. It is commonly supposed that the presence of bromides and iodides, and of lithia gives a mineral water valuable medicinal properties. Be this as it may it is certain that if these exist in the waters examined, they do so in such small quantities as to make them at least unimportant constituents.

Therapeutic
value.

The "totals" given in the table of analyses were obtained by adding the amounts of the individual constituents found in analysis. This quantity was checked in every case by comparison with the weight of the residue from a measured quantity of the water, and the two were found to agree very closely in every case.

THE MINERAL WATERS OF HENRY COUNTY.

THE WELLS AT CLINTON.

The Clinton Artesian Well. — During the summer of 1887, an eight inch well was drilled south of Clinton (in N. W. $\frac{1}{4}$ of S. W. $\frac{1}{4}$ section 10, township 41 north range 26 west.) At the depth of 310 feet, the rate of flow of water from the well is reported to have been 75 gallons per minute, which increased to 200 gallons per minute at 425 feet: this water was termed "sulphur water." At the latter depth the diameter of the drill

History of well.

bit was decreased to $5\frac{1}{8}$ inches, and the drilling continued to 800 feet. The flow down to 425 feet was then separated from that at greater depths by a casing so that two distinct flows were obtained; one, from around the casing, of sulphur water, at 425 feet, at the rate of 200 gallons per minute; the other, through the casing, of fresh water, from 425 to 800 feet, at the same rate of 200 gallons per minute, thus making the combined flow about 400 gallons per minute. The casing is now removed and the waters mix in the well. The well is tubed above the surface of the ground to a height of, perhaps, ten feet. Through this the water rises and flows over into a sheet iron basin, escaping from this into the artificial pond by means of a trough, as is illustrated in the cut on the opposite page. The flow of the water through this trough was measured and found to be about 370 gallons per minute. Part of the water is, however, conveyed directly from the stand-pipe to the bath houses and, considering this, the present flow of the well may fairly be given as 400 gallons per minute. The well is reached by a line of horse cars from Clinton.

An artificial lake receives the overflow from the well where boating and bathing are engaged in. Other improvements, in the way of bath houses and pavilions, have been made, and a large hotel is in process of erection. The water is used extensively both for drinking and bathing, and for the latter purpose is furnished to the bath rooms either hot or cold.

The sample for analysis was obtained by plunging the gallon bottle into the mouth of the stand pipe and allowing it to fill with the water. It was then immediately stoppered and sealed with melted paraffine. The analysis given in the table shows the water to be distinctly a saline water with a small percentage of carbonates present. It is interesting to compare this analysis with the following made from the water of the well which supplies Clinton with water, situated about 500 feet south of the one just described.

The Water Works Well — This well was drilled to a depth of 800 feet with a five inch drill. The present flow, owing to leakage and to the form of the overflow pipe, could not be ascertained, but is certainly less than that of the "Artesian" well.



THE CLINTON ARTESIAN WELL.



PERTLE SPRING, NEAR WARRENSBURG.



The water supply of Clinton is derived entirely from this well, the overflow from the well being collected in a reservoir. The sample for analysis was taken, as before, by plunging the bottle into the stand pipe, and the bottle was sealed immediately with paraffine. Since the two wells are but a short distance apart and were both drilled to the same depth, a correspondence between the analyses of these waters is to be expected. A very considerable difference is found to exist, however. Thus, though both are characterized by a large percentage of sodium chloride the water of this well differs from the Artesian well water by containing larger amounts of carbonates and sulphates. These differences are produced, probably, by the mixing in the water works well of a greater quantity of surface waters with the chloride water, thereby decreasing the amount of total solids and increasing at the same time the amount of alkaline constituents. The following table will show exactly the relation between the two wells:—

Clinton water supply.

Comparison of two wells.

PERCENTAGE COMPARISON OF THE CLINTON ARTESIAN AND THE WATER WORKS WELL.

	Clinton "Artesian."	"Water Works Well."
Total Solids	1.6271 pts. per 1000	.9628 pts. per 1000
Free Hydrogen Sulphide.....	.0041 " " "	.0011 " " "
Free Carbonic Acid and combined as bicarbonate. }	.1748 " " "	.1468 " " "
Potassium Chloride.....	1.94 % of solids.	8.40 % of solids.
Sodium Chloride.....	65.47 % " "	50.90 " " "
Calcium Chloride.....	.08 " " "	.....
Magnesium Chloride.....	4.64 " " "	.....
Calcium Sulphate.....	9.59 " " "	7.17 % " "
Magnesium Sulphate.....	.....	2.52 % " "
Sodium Sulphate.....	.....	8.59 % " "
Magnesium Carbonate.....	6.78 " " "	11.41 % " "
Calcium Carbonate.....	10.78 " " "	15.68 % " "
Chlorides present.....	72.13 " " "	59.80 % " "
Sulphates present.....	9.59 " " "	13.28 " " "
Carbonates present.....	17.56 " " "	26.99 " " "

Results of analyses of other well or spring waters directly comparable to these Clinton waters are not easy to find. The

Fort Scott, Kansas Artesian well water yielded 109.13 grains per gallon. The Clinton Artesian, 95.16. The composition of the two may be compared in the general table.

Other Henry Co.
Springs.

Other springs of note in Henry county are few in number and are for the most part alkaline in character, and are distinguished by the presence of iron carbonate. The list includes the following: —

Location.

1. *The Jordan Artesian Well*, three miles south-east of Clinton, in the south-west quarter of section 19, township 41 north, range 25 west. This is a well of slightly chalybeate water, with a very weak flow. The water flows from the Carboniferous shales and sandstones of the region, and is probably related in composition to the other alkaline springs of the county. The water was formerly much used but is now entirely neglected, and the well is rapidly filling up.

2. A weak "iron" spring, reported to be in or near section 2, township 40 north, range 25 west, on Pretty Bob creek. This spring was not visited.

Location.

3. *The Sand Creek Spring* is situated in the south-west quarter of the north-west quarter of section 28, township 43 north, range 25 west, on a branch of Sand creek, four miles north of Lewis station. It is found in a picturesque valley with sandstone bluffs on either side. There are here two springs emerging from the sandstone, but the one sampled is more important on account of its greater flow (perhaps between 50 and 100 gallons per hour). The iron contained in the water is rapidly oxidized, and is found in the spring and along its course as a brown sediment. It often forms on the surface of the spring as an iridescent scum, which has frequently been mistaken for oil. The flow is reported to be constant and the water is said never to freeze, even in the coldest weather.

Iron in water.

Location.

4. *The Windsor Medical Spring*. This well is found in a grove one mile south of the town of Windsor, in the south-east quarter of the north-east quarter of section 14, township 43 north, range 24 west; it is excavated from a bed of sandstone. The amount of flow could not be determined but the well furnishes water to a very large number of people during the summer months. A hotel of forty-two rooms has been built here, on

elevated ground near the well. Other and more extensive improvements were contemplated but have not, as yet, been begun.

As a mineral water it is remarkable rather for the small amount of solids in solution than for its high mineralization. Among the constituents of the water the alkaline carbonates seem to predominate in place of the carbonates of lime and magnesia.

5. *The Ford Spring at Montrose.* This well (probably supplied by a spring) is situated in the town of Montrose at the corner of Seventh street and Missouri avenue. The well is about twenty-five feet deep and the water is obtained by pumping. It has been improved to some extent and is used a great deal by people living in the vicinity. The water is remarkable as containing a large amount of the sulphates of the alkalies and alkali earths in solution, which are probably derived from the oxidizing pyrites in the shales below.

These five springs with the two wells at Clinton represent the mineral waters of Henry county; but it is probable that nearly all of the true springs in the county contain small amounts of lime and magnesia salts in solution and also iron where the conditions are favorable. The artesian wells at Clinton, without doubt, furnish the most important and desirable mineral water to be found in the county, and in volume of water far surpasses every thing else.

THE MINERAL WATERS OF ST. CLAIR COUNTY.

St. Clair county, which lies directly south of Henry county, has the following springs which have now or have had in the past a local reputation:—

1. *The Salt Creek Sulphur Springs.* This is an unimportant spring on Salt creek in the south-west quarter of the north-west quarter of section 27, township 38 north, range 26 west. It is reported to be a weak sulphur water and is probably of similar composition to the water of Monegaw spring (No. 7).

2. An unimportant sulphur spring in section 6, Township 37 north, range 27 west, on the south side of the Osage river.

3. *The Iuka Spring,* near Johnson post-office, in the south west quarter of the south-west quarter of section 32, town-

ship 39 north, range 27 west. This is said to be a "fresh water" spring slightly chalybeate. It is now neglected, but considerable money has been spent on the spring and its surroundings.

4. *The Taberville Spring.* This is a large fresh water spring at Taberville in lower half of north-west quarter section 3, township 37 north, range 28 west. This is much resorted to during the summer.

5. *The Guller Spring.* This is reported to be a fresh water spring in section 34, township 36 north, range 25 west.

Location. 6. On the west side of Little Monegaw Creek, in the north-east quarter of the north-east quarter of section 14, township 38 north, range 27 west, is an alkaline spring containing iron. The water flows from the limestone bluff. The yellow hydrate of iron is deposited around this spring and for years past this has given it a reputation as an "iron water" and has caused the spring to become a resort for such by visitors from Monegaw Springs. The water flows at the rate of about one hundred gallons per hour. The poor condition of the roads made the spring difficult of approach and improvement in this respect would much increase its value to the frequenters of Monegaw Springs.

Location. 7. *The Monegaw Springs.* These springs are situated on the north side of Little Monegaw creek in the south-east corner of the south-west quarter of the north-west quarter of section 30, township 38 north, range 26 west, perhaps three quarters of a mile from the Osage river. On the north side of the creek the bluff rises abruptly to a height of 150 feet above the level of the creek and from the summit of this bluff there is a magnificent view across the Osage valley. There are here about nine springs in all, situated in the very bed of Monegaw creek, so that at times of high water they are all flooded. The difficulty in obtaining water caused by this could, however, be easily obviated by forcing the spring water to flow up through an iron pipe, as has been successfully done with one spring in the vicinity. The most important spring, and the largest, is termed "Old Black." At the time of the writer's visit to Monegaw all of the springs were flooded, but a sample was obtained by carefully forcing a corked empty jug down into the spring water and then, by pulling the

Natural advantages.

Mode of sampling.

cork out, the jug was filled while totally immersed. The analysis given in the table was made of a sample from Old Black spring taken in this manner. The locality has many natural advantages for a summer resort, and it has been favorably known for a long time. The analysis indicates it to be an alkaline-saline water. Other analyses given in the table offer the means of comparing the water with others of more or less note. The small amount of free carbonic acid is due to the manner of taking the sample.

Character of
water.

Monegaw Springs is evidently destined to be the prominent mineral water resort of St. Clair county, and it is certainly admirably situated for such. It is reached either from Osceola or from Clinton in Henry county.

THE MINERAL WATERS OF BENTON COUNTY.

Boling Spring. This is situated in the west central part of Benton county on the north side of the Osage river. It is in a remote part of the county in a rugged country, and the roads leading to it are in poor condition. Nevertheless it is made a resort by parties during the summer and has a local reputation. Its exact location is very near where Benton, Henry and St. Clair counties meet or about section 30, township 40 north, range 23 west. The flow of water is strong, about 5000 gallons per hour. The composition is given in the table of analyses. It contains a small amount of free hydrogen sulphide at the spring but not enough to show in analysis. It is an alkaline-saline water.

Location.

Volume of flow.

Character of
water.

The remaining springs of Benton county will be noticed in another report.

THE MINERAL WATERS OF JOHNSON COUNTY.

The most important springs of Johnson county are the alkaline springs containing iron carbonate. Sulphur springs exist and one which was visited and sampled is found on the Post Oak Creek branch of the Black Water river in or near section 11, township

Character of
springs.

46 north, range 26 west, but most of the springs of this character are unimportant. A spring, the existence of which has been known for a long time in this county, is found about eight miles south of Warrensburg in the north-east quarter section 29, township 45 north, range 26 west, on land of D. W. Reed. It is a weak alkaline spring, flowing at a rate of perhaps 200 gallons per hour, the water of which deposits the yellow ferric hydrate. It is used to a small extent, locally. An analysis of the water is given in the table.

Location.	<i>The Sulphur Spring</i> north of Warrensburg is situated in the alluvial plane of Post Oak creek. The rate of flow is about 150 gallons per hour. It is very weak in mineral matter and weak in hydrogen sulphide. It receives very little attention but is interesting as belonging to an entirely different class of waters from that of the other springs of the vicinity. The excess of sodium chloride above the other substances present, together with the temperature of the water and the presence of hydrogen sulphide, at once indicate a different origin from that of the alkaline springs of the county.
Character of water.	

Location.	<i>The Colburn or Electric Spring.</i> This spring is situated in the northern part of the town of Warrensburg, in a small valley cut into the sandstone of the region. The spring and surrounding grounds are owned by the Electric Spring company. The spring itself has been improved and a hotel has been built on a neighboring hill. It is frequented as a health resort. The water of the spring flows at a rate of 200 ²⁵³ gallons per hour and is
Character of water.	alkaline, deriving its carbonate of lime from the beds immediately underlying the Warrensburg sandstone. It carries, for this class of springs, an exceptional amount of mineral matter in solution.

Improvements	<i>The Pertle Spring.</i> This spring is situated about one mile south of Warrensburg and is at present a very popular resort. The grounds about the spring have been improved by the construction of a spring house, hotel, summer houses and an artificial lake. The cut opposite p. 90 gives a view of some of the surroundings. The water emerges from sandstone, but this is in close association with coal and limestone beds and thus one is led to expect the predominance of carbonates and sulphates proved
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by the analysis, which shows it to be an alkaline water with quite a large proportion of iron carbonate. It is reached from Warrensburg by a dummy line. ^{Character of water.}

A spring at Grand Pass, which supplies that town with water, was visited during March and sampled for analysis. It is an alkaline (carbonate) water containing a small amount of iron in solution. The water from another similar spring a few yards away is used in the locomotives of the Missouri Pacific railway.

TABLE OF ANALYSES OF HENRY COUNTY MINERAL WATERS.*

	"Artesian Well" Clinton.		"Water Works Well," Clinton.		Sand Creek Spring.		Windsor Spring.		Montrose Well.	
	Pts. in Grs. pr 1000.	Pts. in Grs. pr Gal.	Pts. in Grs. pr 1000.	Pts. in Grs. pr Gal.	Pts. in Grs. pr 1000.	Pts. in Grs. pr Gal.	Pts. in Grs. pr 1000.	Pts. in Grs. pr Gal.	Pts. in Grs. pr 1000.	Pts. in Grs. pr Gal.
Potassium Chloride.....	.0917	1.85	.0809	4.75	.0102	.60	.0021	.12	.0027	.16
Sodium Chloride.....	1.0658	62.32	.4901	28.67	.....	.....	.....	.....	.....	.....
Calcium Chloride.....	.0014	.08	.....	.....	.....	.....	.....	.....	.....	.....
Magnesium Chloride.....	.0762	4.40	.....	.....	.....	.....	.....	.....	.....	.....
Potassium Sulphate.....	.....	.....	.....	.....	.0438	2.58	.0188	.81	.0317	1.85
Sodium Sulphate.....	.....	.....	.0846	2.02	.....	.....	.0018	.11	.8340	19.54
Calcium Sulphate.....	.1661	9.12	.0690	4.03	.....	.....	.....	.....	1.1404	66.71
Magnesium Sulphate.....	.....	.....	.0243	1.42	.....	.....	.....	.....	.8490	20.42
Potassium Carbonate.....	.....	.....	.....	.....	.0311	1.82	.....	.....	.....	.....
Sodium Carbonate.....	.....	.....	.....	.....	.....	.....	.0258	1.49	.....	.....
Calcium Carbonate.....	.1754	10.26	.1500	8.76	.1147	6.71	.0098	.54	.2527	14.78
Magnesium Carbonate.....	.1108	6.45	.1099	6.43	.0667	3.32	.0088	.52	.....	.....
Iron Carbonate.....	.....	.....	.....	.....	.0081	.18	.....	.....	.0588	3.41
Alumina.....	.....	.....	.....	.....	.0016	.09	.0072	.42	.....	.....
Silica.....	.0117	.68	.0040	.23	.0184	1.08	.0120	.70	.0088	.51
Total Solids found by Analysis.....	1.6271	95.16	.9628	56.31	.2760	16.15	.0805	4.71	2.1198	128.97
Gases { Carbonic Acid free and combined as bicarbonates.....	.1748	10.23	.1468	8.59	.1439	8.42	.0318	1.86	.2016	11.79
Free Hydrogen Sulphide.....	.0041	.24	.0011	.06	.....	.....	.....	.....	.....	.....
Temperature of Water.....	58° F.	58° F.	56° F.	56° F.	49°	49°	47°	47°	49°	49°
Temperature of Air.....	68° F.	68° F.	68° F.	68° F.	68°	68°	74°	74°	48°	48°
Flow in Gallons per hour.....	24000	24000	10000-20000	10000-20000	100	100	.....	.....	.....	.....

* The samples from which analyses of Missouri waters were made, were collected by the Survey, and the analyses were conducted in duplicate.

The water supply of Clinton is derived entirely from this well, the overflow from the well being collected in a reservoir. The sample for analysis was taken, as before, by plunging the bottle into the stand pipe, and the bottle was sealed immediately with paraffine. Since the two wells are but a short distance apart and were both drilled to the same depth, a correspondence between the analyses of these waters is to be expected. A very considerable difference is found to exist, however. Thus, though both are characterized by a large percentage of sodium chloride the water of this well differs from the Artesian well water by containing larger amounts of carbonates and sulphates. These differences are produced, probably, by the mixing in the water works well of a greater quantity of surface waters with the chloride water, thereby decreasing the amount of total solids and increasing at the same time the amount of alkaline constituents. The following table will show exactly the relation between the two wells:—

Clinton water supply.

Comparison of two wells.

PERCENTAGE COMPARISON OF THE CLINTON ARTESIAN AND THE WATER WORKS WELL.

	Clinton "Artesian."	"Water Works Well."
Total Solids	1.6271 pts. per 1000	.9628 pts. per 1000
Free Hydrogen Sulphide.....	.0041 " " "	.0011 " " "
Free Carbonic Acid and combined as bicarbonate. }	.1748 " " "	.1468 " " "
Potassium Chloride.....	1.94 % of solids.	8.40 % of solids.
Sodium Chloride.....	65.47 % " "	50.90 " " "
Calcium Chloride.....	.08 " " "	.....
Magnesium Chloride.....	4.64 " " "	.....
Calcium Sulphate.....	9.59 " " "	7.17 % " "
Magnesium Sulphate.....	.....	2.52 % " "
Sodium Sulphate.....	.....	3.59 % " "
Magnesium Carbonate.....	6.78 " " "	11.41 % " "
Calcium Carbonate.....	10.78 " " "	15.58 % " "
Chlorides present.....	72.13 " " "	59.30 % " "
Sulphates present.....	9.59 " " "	13.28 " " "
Carbonates present.....	17.56 " " "	26.99 " " "

Results of analyses of other well or spring waters directly comparable to these Clinton waters are not easy to find. The

TABLE OF ANALYSES OF WATERS FROM ST. CLAIR AND BENTON COUNTIES AND ONE FROM GRAND PASS, SALINE CO.*

	"Old Black," at Monegaw Springs, St. Clair Co.		"Bolling Spring," Benton Co.		Town Spring, at Grand Pass, Saline Co.	
	Parts in 1000.	Grains per Gallon.	Parts in 1000.	Grains per Gallon.	Parts in 1000.	Grains per Gallon.
Potassium Chloride.....	.0466	2.78	.0261	1.53	.0008	.05
Sodium Chloride.....	1.9055	111.66	.6051	35.40	.....	.....
Calcium Chloride.....	.1554	9.11	.0187	.80	.....	.....
Magnesium Chloride.....	.0290	1.70	.0689	4.08	.....	.....
Potassium Sulphate.....	.....	.....	.....	.....	.0109	.64
Sodium Sulphate.....	.....	.....	.....	.....	.....	.....
Calcium Sulphate.....	.0545	3.19	.0683	4.00	.....	.....
Magnesium Sulphate.....	.....	.....	.....	.....	.....	.....
Potassium Carbonate.....	.....	.....	.....	.....	.0159	.93
Sodium Carbonate.....	.....	.....	.....	.....	.0631	3.11
Calcium Carbonate.....	.1929	11.30	.1967	11.51	.1535	8.92
Magnesium Carbonate.....	.1876	10.99	.0873	5.13	.0455	2.66
Iron Carbonate.....	.....	.....	.....	.....	.....	.....
Alumina.....	.....	.....	.....	.....	.0156	.91
Silica.....	.0111	0.65	.0106	.63	with iron	with iron
Total solids found by analysis.....	2.5236	151.38	1.0766	63.01	.0192	1.12
Gases { Carbonic Acid free and combined as bicarbonates.....	.0632	3.64	.1759	10.39	.3135	18.84
Free Hydrogen Sulphide.....	.0086	.21	trace.	trace.	.1062	6.22
Temperature of Water.....	61° F.	.....	56° F.	.....	.....	.....
Temperature of Air.....	55° F.	.....	57° F.	.....	.....	.....
Flow in Gallons per hour.....	10000	.....	5000	.....	.....	.....

* The samples from which analyses of Missouri waters were made were collected by the Survey, and the analyses were conducted in duplicate.

TABLE OF ANALYSES OF COMPARABLE WATERS FROM OTHER STATES.

	Blount Mineral Spring, ¹ Alabama. ¹	Bethesda Spring, Wau- kegan, ² Wisconsin. ²	Artesian Well, Prairie du Chien, ³ Wisconsin. ³	Artesian Well, Fort Scott, Kansas. ⁴	"Gettysburg," Lithia Spring, ⁵ Pennsylvania. ⁵	Scribbling or Au- gusta Springs, Virginia, No. 1, Chaly- beate Spring. ⁶
	Gra. per Gal.	Gra. per Gal.	Gra. per Gal.	Gra. per Gal.	Gra. per Gal.	Gra. per Gal.
Potassium Chloride.....	.....	.....	3.81	trace.	.....	.....
Sodium Chloride.....	32.32	1.16	90.20	79.47	.82	.....
Calcium Chloride.....	.....	.....	{ Sodium bromide. .18	0.79	.....	.....
Magnesium Chloride.....	6.00	.....	.....	7.99	.....	.....
Potassium Sulphate.....	.....	.46	.....	{ Sodium bichlorate. 2.20	.15	.....
Sodium Sulphate.....	.....	.54	12.80	trace.	{ Calcium phosphate. .01	.....
Calcium Sulphate.....	.....	.....	15.37	0.88	.48	.22
Magnesium Sulphate.....	1.60	.....	.....	{ Sodium hydro-sul- phide .19	3.30	.....
Potassium Carbonate.....	.....	bicarb.	.....	.....	.....	.35
Sodium Carbonate.....	.....	{ 1.26 bicarb.	.....	.....	{ bicarb. 8.38	.76
Calcium Carbonate.....	6.80	{ 17.02 bicarb.	{ bicarb. .62	bicarb.	{ bicarb. 9.96	1.50
Magnesium Carbonate.....	4.40	{ 12.89 bicarb.	10.97	bicarb.	{ bicarb. 5.83	.98
Iron Carbonate.....	1.92	{ .04 bicarb.	{ bicarb. .28	1.00	{ bicarb. .04	.07
Alumina.....	.....	{ .12 & organic matter.	.06	.....	.02	.....
Silica.....	.....	35.71	2.84	{ 2.12 & organic matter.	1.76	1.83
Total Solids found by analysis.....	53.04	.....	137.08	109.15	25.25	5.21
Gases { Carbonic Acid free & comb. as bicarb.. Free Hydrogen Sulphide.....	present. present.	.....	.....	trace.	.....	24.00
Temperature of water.....	60° F.	48° F.	56° F.	67.5° F.	.....	.....
Temperature of air.....	.....	.....	.....	.....	.....	.....
Flow in gallons per hour.....	900	4200	3620	416	.....	.....

¹ R. Brumby, Analyst.² O. F. Chandler, Analyst.³ G. Bode, Analyst (1876).⁴ D. E. Tuttle, Analyst (1869).⁵ E. H. S. Bailey and E. W. Walters, Analysts (1884).

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GEOLOGICAL SURVEY OF MISSOURI.

ARTHUR WINSELOW, STATE GEOLOGIST.

BULLETIN No. 4.

A DESCRIPTION

OF SOME

LOWER CARBONIFEROUS CRINOIDS

FROM

MISSOURI.

By S. A. MILLER.

PUBLISHED BY
THE GEOLOGICAL SURVEY.

JEFFERSON CITY,
FEBRUARY, 1891.

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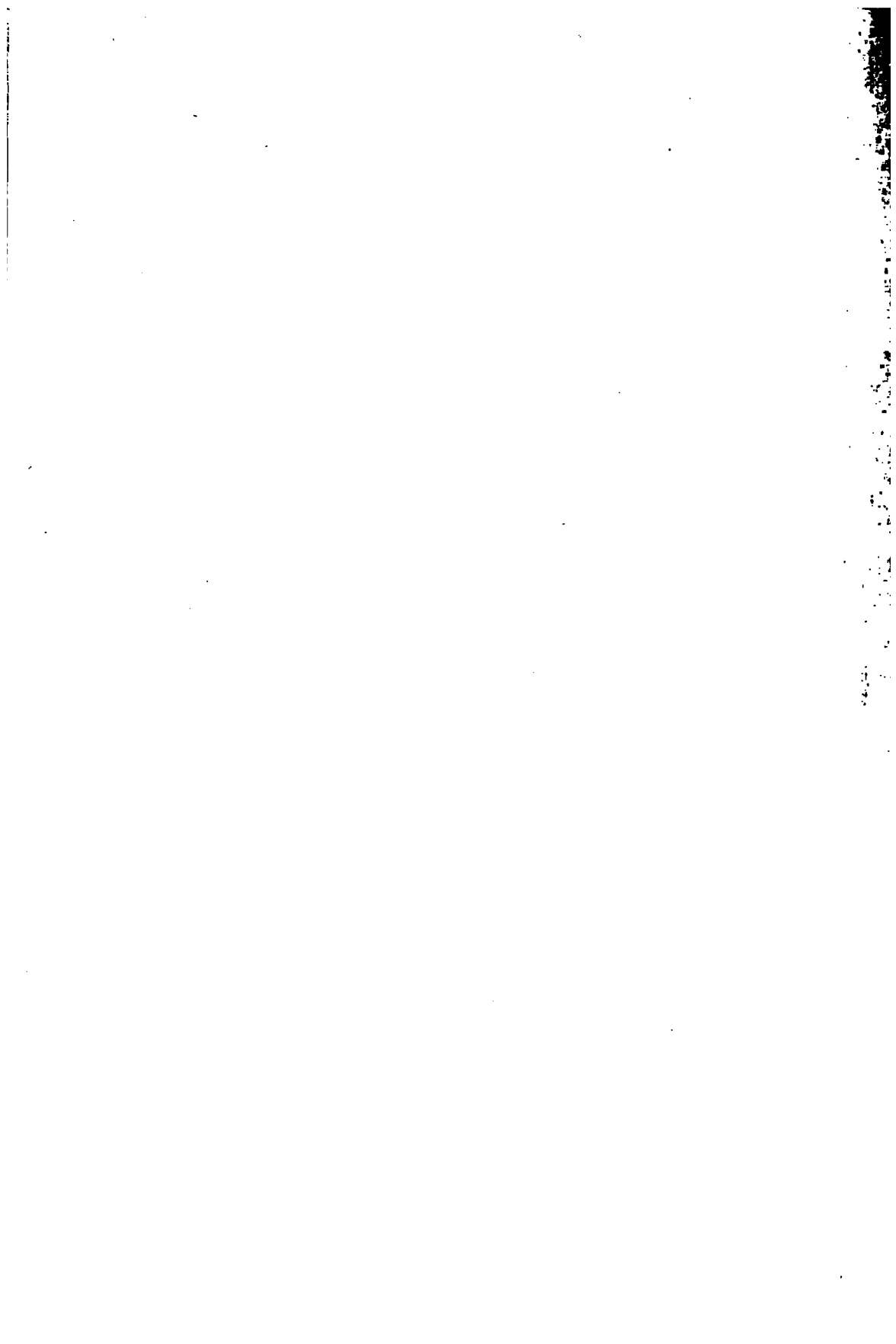
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	Parts in 1000.	Grains per Gallon.	Parts in 1000.	Grains per Gallon.	Parts in 1000.	Grains per Gallon.
Potassium Chloride.....	.0466	2.78	.0261	1.53	.0008	.05
Sodium Chloride.....	1.9055	111.66	.6051	35.40	.....	.....
Calcium Chloride.....	.1554	9.11	.0187	.80	.....	.....
Magnesium Chloride.....	.0290	1.70	.0689	4.03	.....	.....
Potassium Sulphate.....	.....	.....	.....	.....	.0109	.64
Sodium Sulphate.....	.....	.....	.....	.....	.....	.....
Calcium Sulphate.....	.0645	3.19	.0688	4.00	.....	.....
Magnesium Sulphate.....	.....	.....	.....	.....	.....	.....
Potassium Carbonate.....	.....	.....	.....	.....	.0159	.98
Sodium Carbonate.....	.....	.....	.....	.....	.0631	3.11
Calcium Carbonate.....	.1929	11.30	.1967	11.51	.1525	8.92
Magnesium Carbonate.....	.1876	10.99	.0872	5.12	.0455	2.66
Iron Carbonate.....	.....	.....	.....	.....	.....	.....
Alumina.....	.....	.....	.....	.....	.0156	.91
Silica.....	.0111	0.65	.0106	.62	with iron	with iron
Total solids found by analysis.....	2.5926	151.38	1.0766	63.01	.0192	1.12
Gases { Carbonic Acid free and combined as bicarbonates.....	.0622	3.64	.1759	10.29	.3135	18.84
Free Hydrogen Sulphide.....	.0086	.21	trace.	trace.	.1062	6.22
Temperature of Water.....	61° F.	.....	58° F.	.....	.....	.....
Temperature of Air.....	59° F.	.....	57° F.	.....	.....	.....
Flow in Gallons per hour.....	10000	.....	5000	.....	.....	.....

* The samples from which analyses of Missouri waters were made were collected by the Survey, and the analyses were conducted in duplicate.

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By S. A. MILLER.

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A DESCRIPTION
OF SOME
LOWER CARBONIFEROUS* CRINOIDS
FROM MISSOURI.

BY S. A. MILLER.

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INTRODUCTION.

Sub-Carboniferous was applied, as a technical name, to the system of rocks above the Devonian and below the Coal Measures

* The term Lower Carboniferous is adopted here by the Survey as a synonym for the term Sub-Carboniferous used by Mr. Miller. A. W.

by David D. Owen, in 1838. The lower part of the Sub-Carboniferous system was called the Waverly Sandstone, at that time, and later was called the Waverly group, in Ohio and Indiana, and the Marshall group in Michigan, and the Kinderhook group in Illinois, and the Chouteau group in Missouri. The rocks succeeding the Chouteau group are called the Burlington group, and these are followed by the Keokuk group. These three groups constitute the lower half of the Sub-Carboniferous system, and it is from these rocks that the fossils herein described were collected.

Mr. R. A. Blair and Mr. F. A. Sampson of Sedalia, Missouri, have been ardent collectors and students of Natural History, for many years, and it is to their labor and zeal that we are indebted for the fossils described in this paper. They have made very large collections, and it is quite a noteworthy fact, that all the crinoids which they have found, in the Chouteau group, belong to undescribed species and represent peculiar generic forms.

The fossils from the Chouteau group, were collected from Bank's quarry, in section 28, township 46, range 21 west, one mile north of Sedalia; Leucke's quarry, in section 16, township 46, range 20 west, six miles southeast of Sedalia; Beaman's station, in section 20, township 46, range 20 west, six miles northeast of Sedalia; Pin Hook bidge, in section 36, township 47, range 21 west, seven miles northeast of Sedalia and Cedar Creek Crossing, in section 21, township 45, range 21 west, thirty-three miles north of Sedalia. Luecke quarry and Beaman station are geologically lower than the exposures, at Sedalia, and, at Pin Hook bidge, the valley cuts through the Chouteau group. The fossils from the Burlington group are from the Georgetown cut, in section 17, township 48, range 21 west, three miles northwest of Sedalia, and the Sedalia quarries.

The fossils from the Keokuk group are from the shaly archimedes beds overlying the blue limestone, at Boonville, about half a mile above the railway bridge and ten feet above the track in section 34, township 49 N., range 17 W. These archimedes beds have been generally referred, at this place, to the Warsaw group, which is above the Keokuk. The Warsaw group is not of great thickness and has been classed, by some, as the upper

member of the Keokuk group, and, by others, as the lower member of the St. Louis group. The name is retained, because of an association of small fossils, that seem to characterize it, at distant localities, and without which it could not be determined. A few small Brachiopods occur, at Boonville, closely allied to some of those found at Spergen Hill, Indiana, and at Alton, Illinois, but the species may not be identical, while the crinoids have the aspect of those from the Keokuk group rather than those from the St. Louis group. After careful consideration of the general appearance of the fossil remains, I have decided that these Boonville beds should be referred to the upper part of the Keokuk group, rather than to the Warsaw group. I admit, however, that they may, possibly, be the equivalent of some part of the Warsaw beds, at other places, but I cannot see sufficient reason for so classifying them, in the face of the paleontological evidence afforded by the fossils now at hand. This subject, however, deserves more than the passing notice now taken of it, and can only be finally determined and settled by a further study of the fossils.

The genus *Platycrinus* has an almost world-wide distribution, where rocks of the Sub-Carboniferous age are exposed; it is also a Silurian and Devonian genus, and it is one of the earliest genera defined; and yet, we are able to describe, from these collections, a quarter as many species as have been hitherto described, or twenty-three new species, and there are fragments, of other new species, too imperfect for definition, beside a few species that occur in rocks of the same age in other localities. The variety of forms is truly wonderful, for every shape and character of this genus found elsewhere seems to be represented in these collections. Other genera are represented by numerous species, some of which are remarkable for their variations from the typical forms, without departing from the formula upon which the genera are constructed; but it will be more instructive, probably, to call attention to peculiarities in the specific descriptions, than to dwell generally upon such matters in advance.

Some species are in Mr. Sampson's collection that were never found by Mr. Blair, and *vice versa*, and in some cases the new

species is represented by a single specimen. All of Mr. Sampson's specimens sent to the author are returned to him, for his private collection, and hence, when he alone has found the species described, it is referred to simply as collected by him, at the particular locality. The collection of Mr. Blair was presented to the author before the establishment of the Missouri Survey; but where there are duplicates of new species in the collection, a division is made, as desired by him, so that authentic specimens are presented by him to the museum of the Geological Survey, and no doubt a complete representation of all the species defined will soon find a place in the museum. This statement is made here to avoid referring to the collection in which each type is to be found, at the end of each description. Where both Mr. Blair and Mr. Sampson collected the same new species, the first name mentioned, at the end of the description, indicates the one who collected the species illustrated.

PLATYCRINUS BOONVILLENSIS n. sp.

Plate I, Fig. 7, lateral view; Fig. 2, basal and lateral view of a compressed specimen.

Calyx large, bowl shaped, wider than high; radials longitudinally convex or tumid so as to give a slightly pentagonal outline when seen from above; sutures beveled even more distinctly than shown in the illustrations; surface granular; basals forming a low, expanding, rounded cup, with a pentagonal upper face and a round expanding rim projecting below the point of columnar attachment, and having a deep, wide, columnar socket radiately furrowed. Each basal plate might be compared, in its shape, with the back part of a high heeled shoe having the counter inclined backward. Radials a little wider than long, gradually expanding above, tumid longitudinally, in the central part, most prominent at the articulating facets for the second radials, basal and radial sutures beveled, concave facets on the upper face for the articulation of the second radials a little more than one-third the width of the plates; plates much

thicker at the facets than at other places and sloping from the facets to the radial sutures, instead of having a horizontal truncation. Vault high, plates tumid, some of them spinous; column very large, round at the base of the calyx, but from scattering plates supposed to be elliptical below; columnar canal small and round, at the upper end.

Collected by R. A. Blair and F. A. Sampson, in the Keokuk group, at Boonville, Missouri.

PLATYCRINUS ALLOPHYLUS n. sp.

Plate I, Fig. 3, typical form; Fig. 4, a shorter and more robust form and probably a distinct species, but the material at hand does not warrant a separate name for it.

Calyx abruptly expanded below, cylindrical above the basal expansion and gradually expanding in the upper half; radials tumid in the upper part, so as to give a marked pentagonal outline above; sutures slightly beveled; surface apparently smooth. Basals forming a high cylindrical cup with a thin expanded rim at the bottom; this cup is abruptly truncated below, and sunken at the point of the columnar attachment. First radials longer than wide, gradually expanding above, convex in the central part of each and projecting at the articulating facets, for the second radials, and depressed at the longitudinal sutures; facets for the articulation of the second radials more than one-third the width of the plates, nearly perpendicular or having the face of each directed outward. Second radials short, axillary. The three interradials are of about the same size, stand upright, and the lateral ones project outward as far as the face of the second radials, allowing large arm openings. Vault highly convex and covered with large spiniform plates. Column round, medium size, plates radiately furrowed near the outer edge, so as to show the serrations on the outer face of the column.

The general form of the calyx of this species is quite different from that of any other described species of *Platycrinus*, but I see no reason to doubt that it properly belongs to that genus.

After the illustrations were made I received from Mr. Sampson other specimens, showing the second radials, interradians, and part of the vault which are above described.

Collected by F. A. Sampson, in the Chouteau Limestone at Leucke's quarry six miles southeast of Sedalia, Missouri.

PLATYCRINUS OCCIDENTALIS n. sp.

*Plate I, Fig. 5, basal view, part of the azygous side being broken off;
Fig. 6, view of the vault and side.*

Calyx very shallow, the basal plates rising internally as high as the top of the radials; base depressed; sutures in broad angular depressions; surface apparently finely granular. Basals small sunken so as not to be visible in a side view, anchylosed, concave and deeply sunken, in the middle, for the columnar attachment. First radials large, peculiarly prolonged, in the direction of the rays, and at right angles to the height of the calyx, constricted in the middle part and turning the sides and edges up vertically so as to give a basal view a strong stellate outline; bordered by a convex elevation adjoining the basal and radial sutures and having a broad circular concave depression in the middle part, and a narrower one near the prolonged end of each plate; ends of the plates semicircular, each having a small arm furrow on the upper face; regularly serrated upon the outer edges and irregularly furrowed within, for the firmer attachment of the second radials. Interradians three, large, rising vertically from the upturned edges of the first radials; the middle one the larger, heptagonal and having the upper end prolonged between the large vault plates; the lateral ones pentagonal in some of the areas, and hexagonal in others. The middle plate in the azygous area is truncated at the top, by a smaller plate which adjoins the azygous opening, and a small elongated plate is inserted between it and the vault plates on the right, which does not occur in the other areas. The azygous opening is not elevated above the other parts of the vault, but is surrounded by small protuberant plates. The vault is covered with large tumid

plates, some of which terminate in a prominent tubercle; the central one is the larger and irregularly octagonal by reason of abutting two of the small plates that adjoin the azygous opening. The vault plates are continued over each ray. Column small.

Collected by R. A. Blair in the silicified rocks of the Burlington group, near Sedalia, Missouri. Only a single specimen was found.

PLATYCRINUS PULCELLUS n. sp.

Plate I, Fig. 7, basal view.

Calyx very shallow, three times as wide as high, surface completely covered with nodes, sutures beveled, or marked by a strong angular groove. Basals forming a pentagonal disk with the central part depressed for the attachment of the column. First radials low, wider than high, gradually expanding above. Articulating scar for the second radials slightly excavated at the top of each radial and extending down upon the outside, half the length of the plates, forming a semi-elliptical depression. Column evidently small.

This is a very beautiful little species having some resemblance to *P. cavus*, but distinguished by the character of the nodes, by having no plain space surrounding the articulating scars and in having no such elevated ridge surrounding the scars as characterizes the latter species. In *P. cavus* the radials project, at the articulating scars, so as to make the calyx pentagonal; in this species the upper part of the calyx is almost circular.

Collected by R. A. Blair, in the Burlington group, near Sedalia, Missouri. Only a single specimen collected.

PLATYCRINUS AETERNALIS n. sp.

Plate I, Fig. 8, side view of a specimen with the arms and part of the column.

Calyx bowl shaped, sub-pentagonal, wider than high, sutures slightly beveled, surface smooth or granular. Basals low, con-

stricted, so as to form a rounded ring extending below the point of the columnar attachment, each upper face for the support of the radials concave. First radials wider than high, gradually expanding above; articulating facets for the second radials about two-thirds the width of the plates and sloping downward and outward in the central part of the plates; upper faces of the plates slope latterly from the articulating facets to the sutures so as to form rather sharp angles. Second radials, small, triangular, axillary and covering only half the articulating facets. First secondary radials rest on one side upon an upper sloping side of a second radial and the other part, upon part of the articulating facet of a first radial, and support a single axillary, second secondary radial, which in turn supports upon its upper sloping sides the free arms. The inner arms in each radial series bifurcate upon the second plate, making six arms in each series, or thirty arms. The arms consist of cuneiform plates as high as the eighth or ninth plate in the outer arms of each series and as high as the fourth or fifth plate on the four inner arms of each series, above which the arms are composed of a double series of interlocking plates. Column sub-elliptical, flattened and twisted up to the base of the calyx.

Collected by R. A. Blair, in the Keokuk group, at Boonville, Missouri. Only a single specimen was found, which is illustrated.

PLATYCRINUS ACCLIVUS, n. sp.

Plate I, Fig. 9, view of a slightly compressed specimen, as high as the second radial; Fig. 10, opposite view of the same specimen with plates broken at the top.

Calyx somewhat obconoidal, nearly one-half higher than wide, slightly angular in the direction of the arms, sutures distinct but not beveled, surface apparently smooth, but our specimen may not preserve the true surface ornamentation. Basals form an obeonic sub-pentagonal cup a little wider than high, and

truncated below. Radials a little longer than wide, very slightly expanding above and terminating in the central part with an upward prolongation for the articulation of the second radials; the articulating facet is at right angles to the length of the calyx or, having its face upward, it is less than one-third the width of the plate, subcircular in outline, with the exception of a slight truncation and the small concave arm furrow. Column, round, large, central perforation small, plates radiately furrowed near the outer margin.

This species need not be mistaken for any other, because in *P. planus*, and others having any resemblance to it, the angularity of the cup follows the radial sutures and there are deep excavations for the insertion of the second radials.

Collected by R. A. Blair, in the Burlington group, near Sedalia, Missouri. Only a single specimen was found, which is illustrated.

PLATYCRINUS SAMPSONI n. sp.

Plate I, Fig. 11, side view.

Calyx large, deep, one-third higher than wide, not expanding, pentagonal, constricted below the arms. Basals form a very shallow, pentagonal cup. Radials one-third higher than wide, sides nearly parallel, articulating scar for the second radials shallow and a little more than half the width of a plate. This species is founded upon a cast, from the chert in the Burlington group, near Sedalia, Missouri, and, hence, we know nothing of the surface markings. On account of the large size and great proportional length of the calyx it will not be mistaken for any other described species and it is especially distinguished, by its depressed pentagonal basal cup and remarkably long radials with parallel sides and constricted upper ends.

Collected by F. A. Sampson, in whose honor the specific name is proposed.

PLATYCRINUS ANNOSUS n. sp.*Plate I, Fig. 12, side view.*

Calyx small, broadly rounded below, somewhat half globular in shape, except the projections at the arm bases, which give the top a somewhat pentagonal outline. Surface smooth or granular. Basals large, forming a low, rounded, pentagonal disk, having a height scarcely greater than the thickness of the plates; very slight concavity in the central part for the reception of a small column. First radials slightly wider than high, expanding, convex toward the articulating scar. Articulating scar small, semicircular, face directed upward and occupying about one-third the width of a plate; notched in the central part.

Collected in the Chouteau Limestone near Sedalia, Missouri, by F. A. Sampson.

PLATYCRINUS AEQUITERNUS n. sp.*Plate I, Fig. 13, side view.*

Calyx obconoidal, truncated below, rapidly expanding, projecting at the arm bases, diameter at the top one-third greater than the height. Basals forming an expanding cup, the lower part extending in a ring, below the point of the columnar attachment, and the superior faces supporting the first radials being distinctly concave. First radials longer than wide, gradually expanding, convex longitudinally, depressed toward the sutures, and tumid or projecting toward the articulating scars. Articulating facets, forming more than a half circle, nearly perpendicular or having the faces, directed outward and occupying a little more than half the width of the plates; broadly notched in the central part. Column medium size, round, plates radiately furrowed.

Collected in the Chouteau Limestone near Sedalia, Missouri, by F. A. Sampson.

PLATYCRINUS GORBYI, n. sp.

Plate I, Fig. 14, basal view.

Calyx large, pentagonal, very shallow, three times as wide as high; plates thick, sculptured; sutures beveled. Basals forming a pentagonal disk, bearing large nodes or rudely sculptured toward the outer margin, and sunken, in the central part, for the attachment of a comparatively small column. First radials large, prolonged horizontally, in the direction of the rays or at right angles to the height of the calyx, but not extending so far as they do in *P. occidentalis*; gradually expanding, from the basals following the sutures to the interradials, and curving upward, but projecting almost horizontally, in the central part, and constricted immediately behind the large articulating facets, which perpendicularly truncate the middle third of the plates; surface having two rows of nodes below the constriction, which coalesce on some plates, especially on the one nearest the basals, where they form a convex ridge.

Collected by R. A. Blair, in the Burlington Limestone, at Sedalia, Missouri. Only a single specimen found. The specific name is in honor of Prof. S. S. Gorby, recently elected State geologist of Indiana.

PLATYCRINUS ABSENTIVUS, n. sp.

Plate I, Fig. 15, side view.

Calyx medium size, urn shaped; plates thin; sutures slightly beveled; surface smooth or possibly finely granular. Basals forming a low cup, rounded upward, from the point of attachment of a very small column, and having a pentagonal top formed by the slightly arcuating sides for the adjoining radials. First radials a little higher than wide, very slightly expanding upward and slightly projecting in a rim, at the articulating facet for the second radials; articulating scar one-third the width of a plate, semi-circular, at right angles, to the height of the calyx, or hav-

ing the face directed upward, and having a small notch on the interior edge; the upper edges slope from the articulating facets to the radial sutures, forming rather sharp angles at the sutures.

Found by Mr. F. A. Sampson, in the Chouteau group, at Leucke's quarry, six miles southeast of Sedalia, Missouri.

PLATYCRINUS PENTAGONUS, n. sp.

Plate II, Fig. 1, side view with arms.

Calyx pentagonal, bowl-shaped, rounding below to the rim surrounding the column; height and width subequal; surface of our specimen smooth. Basals forming a pentagonal, low, saucer-shaped disk, constricted so as to form a rim around the attaching end of the column. First radials flattened, forming angles at the sutures; height and width subequal, with a concave facet about one-third the width of each plate for the reception of the second radials. Second radials thin, axillary. Arms bifurcate on the second plate, and the two adjoining arms, in each radial series, bifurcate again on the second plate, which gives to the species thirty arms. The arms are long, rather small near the calyx, and composed of a single series of cuneiform plates as high as the fourth plate in the middle arms of each radial series, above which they are composed of a double series of interlocking plates. Pinnules numerous, dense. Interradials of moderate size. Vault unknown. Column round at the calyx.

Collected by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri. Only a single specimen was found, which is illustrated.

PLATYCRINUS SULCATUS, n. sp.

Plate II, Fig. 2, basal view.

Calyx large, pentagonal, very shallow; base deeply sunken and plates rising internally higher than the top of the first radi-

als, sutures in very wide and deep furrows; surface rudely corrugated. Basals sunken to the bottom of the deep furrows, at the radial sutures, and highly inclined so as to present a hollow cone, when viewed from below; the column was attached to the apex of this cone. First radials directed horizontally, rapidly expanding, highly convex and corrugated, or wrinkled bordering the furrowed sutures and basal plates, and deeply concave in the superior central part, so as to give a pentagonal, stellate outline to the base, when viewed from below, with the rays in line with the sutures, instead of being in line with the second radials, as in other species of this genus. Column of medium size and round at the calyx.

Though only the basals and first radials of this species are known, they are so different from all others, that no one can fail to distinguish the species. It occurs in the limestone layers and probably in the chert layers of the Burlington group in Sedalia, Missouri, where it was collected by R. A. Blair. The evidence of its existence in the chert consists in the fragment of a cavity, but the species is founded on a single specimen which is illustrated.

PLATYCRINUS LAUTUS, n. sp.

Plate II, Fig. 3, side view; Fig. 4, azygous view.

Calyx medium size, bowl-shaped, width one-half greater than height; plates thick; radials protuberant in the upper central part, depressed toward the radial sutures; sutures slightly beveled; surface finely granular. Basals saucer-shaped; sutures distinctly depressed; columnar cavity concave and basals regularly rounded, from the column to the upper margin, showing, in a lateral view, a little more than the thickness of the plates. First radials a little wider than high, gradually expanding above, protuberant at the articulating facets for the second radials; facets about two-thirds the width of the plates, semi-circular, and directed downward at an angle of about sixty degrees; upper face notched for the arm furrows, and sloping on the sides

to the radial sutures. Second radials very thin, axillary; each shows two openings to the vault, giving the species ten arms. Three plates in each interradial area, the central one large, the lateral ones narrow, all connecting with the plates of the vault. The central, azygous, interradial plate is very large, convex, and supports the plates of the proboscis. Vault depressed, convex, plates tumid some of them spiniform. proboscis large extending from the interradial area on the azygous side to the central part and inclined from the azygous side. Height unknown. Column small.

Collected by F. A. Sampson, in the Burlington group, at Sedalia, Missouri.

PLATYCRINUS CONCINNUS, n. sp.

Plate II, Fig. 5, view opposite the azygous side, with some of the rock on top, covering the vault; Fig. 6, azygous view showing the proboscis partly surrounded with rock.

Calyx urn-shaped, about as wide as high, slightly angular in the direction of the arms, so as to be sub-pentagonal above; sutures distinct but not beveled; surface apparently smooth, but it may have been finely granular. Basals form a low pentagonal cup, about one-third as high as wide, slightly constricted above the point of the columnar attachment, so as to form a thickening of the plates or rim for the support of the column. Radials expand very slightly above, height and width subequal, low angular ridge in the central part, most prominent at the articulating facets; articulating facets about one-third the width of the plates and the sides slope from them to the radial sutures. Second radials very small, thin, and axillary. First brachials very small. Five openings in the vault from one radial series, and four from another, indicating more than twenty arms in the species. There are three interradials in each area, the middle one is comparatively large and stands upright, the other two are quite small and rest upon the first radials, with the second radials and first brachials, upon one side, and the lower part of the

middle plate upon the other. Upon the azygous side the inter-radials are succeeded by small, polygonal, tumid plates forming a short proboscis. Vault high. Column elliptical.

Collected by R. A. Blair, in the Burlington Group, at Sedalia, Missouri. Only a single specimen found which is illustrated.

PLATYCRINUS OLLICULA, n. sp.

Plate II, Fig. 7, side view; Fig. 8, basal view.

Calyx medium size or rather large, tub-shaped, or having a wide flat bottom, slightly constricted at the top of the basals and expanding very gradually above; plates thick; sutures beveled; surface finely granular. Basals form a round thin plate projecting beyond the lower end of the first radials in the form of a rim, as appears in a side view, and have a small central opening for the columnar canal. Radials truncated at the lower end, a little longer than wide, expand very slightly and protrude most at the articulating facets for the second radials; articulating facets about two-thirds the width of the plates, with the faces at an angle to the column of about forty degrees. This is a species widely different from any hitherto described.

Collected by F. A. Sampson, in the Chouteau group, at Pin Hook bridge and at Leucke's quarry, Missouri.

PLATYCRINUS AMABILIS, n. sp.

Plate II, Fig. 9, side view; Fig. 10, basal view.

Calyx small, sub-pentagonal, when viewed from above, but round below the articulating facets of the second radials, nearly twice as wide as high; plates thick; sutures beveled; surface granular. Basals form a low pentagonal disk, having a height about equal to the thickness of the plates, concave in the central part, and rounded from the point of the columnar attachment

outward and upward. First radials wider than high, moderately expanding, most convex at the articulating facets for the second, radials; articulating facets more than half the width of the plates, semi-circular, and directed downward at an angle to the plates of about forty-five degrees.

Collected by R. A. Blair, and received by me in association with fossils from the Keokuk group, at Boonville, but the form of the species and the character of the rock convince me, that it was found, in the Burlington group, at Sedalia, and was accidentally mixed with Boonville fossils. Only a single specimen was found, which is illustrated.

PLATYCRINUS ROTUNDUS, n. sp.

Plate II, Fig. 11, side view; Fig. 12, basal view.

Calyx rotund or half spherical; plates thick; sutures beveled; surface covered with nodes which sometimes coalesce. Basals form a low cup, rounded below and pentagonal on top; no depression for the column, but a small ring slightly protrudes, which is caused by the thickening of the plates; surface of the plates covered with nodes, arranged in four or five rows parallel with the pentagonal upper face of the basal cup, or in what may be called pentagonal rings, growing less from the top of the cup until the last one surrounds the end of the column; the nodes sometimes coalesce so as to form ridges. Radials about as high as wide, slightly expanding, most convex at the articulating facets, which occupy about one-third the width of the plates, and are directed at an angle to the plates of about forty-five degrees; the upper faces slope very slightly, if at all, from the articulating facets to the sutures; the surface is covered with nodes arranged in lines parallel with the sutures, very much in the same manner as they are upon the basals and frequently coalesce in the same way. Column of medium size and round, at the point of attachment to the calyx.

Collected by F. A. Sampson, in the Burlington group, at Sedalia, Missouri.

PLATYCRINUS BLAIRI, n. sp.

Plate II, Fig. 13, side view; Fig. 14, basal view.

Calyx medium size, bowl-shaped, width nearly twice as great as height, most protuberant at the articulating facets; sutures beveled; surface finely granular. Basals forming a low disk, just visible in a side view, pentagonal on top, sunken below, at the point of the columnar attachment and rounded outward and upward from the column to the top. First radials a little wider than high, gradually expanding, most protuberant, at the facets for the second radials; articulating facets a little more than one-third the width of the plates and directed downward almost perpendicularly or nearly parallel with the column; the upper faces of the first radials slope very rapidly from the facets to the sutures, where acute angles are formed. Interradials three, the middle ones large, long and standing upright, the others small. Vault high, convex, and covered with tumid or somewhat spiniform plates. Column small.

Collected, in the Burlington group, at Sedalia, Missouri, by R. A. Blair, who is a member of the State Geological Board, and in whose honor I have proposed the specific name.

PLATYCRINUS BROADHEADI, n. sp.

Plate II, Fig. 15, side view.

Calyx small, bowl-shaped, width a little greater than height, radials protuberant in the upper central part, so as to make the top sub-pentagonal; sutures beveled; surface finely granular. Basals forming a low pentagonal cup or disk, convex within the margin, so as to show, in a lateral view, a height about equal to the thickness of the plates; moderately concave in the central part for the columnar attachment and rounded outward and upward to the top; sutures between the basal plates depressed or beveled. First radials about as wide as high, slightly expanding above, becoming highly convex or protuberant at the

facets for the second radials; facets a little more than half the width of the plates, semi-circular in outline, directed downward at an angle to the plates of forty-five degrees; upper faces slightly notched for the arm furrows and sloping on the sides to the radial sutures. Second radials thin and axillary giving the species at least ten arms. Three small plates of nearly equal size in each interradian area, the central one being pointed above and the lateral ones extending beyond it. Vault convex, covered with tumid plates, the central one being the larger and having nine sides. Azygous opening surrounded by small plates that do not rise above the summit. Column small.

Collected by R. A. Blair in the Burlington group, at Sedalia, Missouri. Only a single specimen was found, which is illustrated. The specific name is in honor of Prof. G. C. Broadhead, late State geologist of Missouri and now a member of the State Geological Board.

PLATYCRINUS BATIOLA, n. sp.

Plate III, Fig. 1, side view; Fig. 2, basal view.

Calyx bowl-shaped, pentagonal, width a little greater than the height; sutures slightly beveled; surface smooth or granular. Basals forming a low rounded cup, with an elliptical projection below for the attachment to the column, and having a pentagonal upper face; the elliptical projection has a central ridge with concave depressions on each side for the purpose of strengthening the means of fastening the column to the calyx; the columnar canal is quite small. First radials about as wide as long, very slightly expanding, faint trace of angularity, in the middle of the plates, and small projecting rim, at the articulating facets; articulating facets a little more than one-third the width of the plates and directed at an angle to the plates of about forty-five degrees; the angles formed, at the sutures on the upper face, between the articulating facets, quite obtuse.

Collected, by R. A. Blair, in the Burlington group, at Sedalia, Missouri. Only a single specimen was found, which is illustrated.

PLATYCRINUS BRITTSI, n. sp.

Plate III, Fig. 3, lateral view; Fig. 4, another view of the same specimen showing the second radials.

Calyx rather large, bowl-shaped, wider than high; sutures beveled; plates thick; surface granular. Basals forming a low cup, truncated below, with a flattened expanded rim surrounding a large, round columnar facet for the attachment of the column, and pentagonal above; with five concave faces to support the first radials. First radials, width and height about the same, lower face convex, expanding but little above, articulating facets about three-fourths the width of the plates and directed upward, with only a slight inclination. Second radials wide, thin, axillary and concave, on each side of the central dividing elevation. Column round at the calyx, and radiately furrowed, to strengthen the means of attachment; columnar canal small.

Collected by F. A. Sampson, in the Chouteau group, at Pin Hook bridge, Missouri. The specific name is in honor of Dr. J. H. Britts, a member of the State Geological Board of Missouri.

PLATYCRINUS CARCHESIUM, n. sp.

Plate III, Fig. 6, side view; Fig. 7, basal view.

Calyx rather large, urn-shaped, rounded below and subpentagonal above; plates thick; sutures slightly beveled; surface smooth or granular. Basals forming a cup rounded below from a very small column, and pentagonal above, with concave faces for the support of the first radials. First radials about as wide as high, longitudinally convex in the central part, most prominent at the articulating facets, which occupy a little more than one-third the width of the plates, and are directed upward, with a slight inclination; angles at the sutures obtuse.

Collected, by R. A. Blair, in the Burlington group, at Sedalia, Missouri. Only a single specimen found, which is illustrated.

BARYCRINUS BOONVILLENSIS, n. sp.

Plate III, Fig. 5, side view showing column and arms.

Calyx nearly as high as wide, with deep angular depressions at the longitudinal sutures, giving it a pentagonal outline when viewed from above or below. Surface finely granular. Basals forming a low pentagonal cup, with a sharp angle extending up between the sub-radials and a concave depression at each longitudinal suture, resembling in sculpture that which would be made by a circular chisel scooping out a furrow, commencing on a sub-radial and passing down the longitudinal sutures to the column. This sculpturing, with the sunken longitudinal sutures, gives a stellate outline to the surface of the sub-radials. Sub-radials hexagonal, about as wide as high, longitudinal sutures deeply sunken and central part highly angular, with an angular ridge extending to each of the adjacent radials above and abutting basals below. First radials of unequal size, the lateral ones being twice as wide as high, rounded, pentagonal, truncated nearly the entire width above, so as to present a broad, concave, almost half circular outward sloping facet, for the reception of the brachial pieces; the radial opposite the azygous side being only a little wider than high and having a much less concave upper facet. Brachials two in each ray, wide, rounded, the first one thin, the second one about twice as thick as the first and axillary. Arms apparently ten, rounded externally and giving off branchlets or armlets about every fourth or sixth plate, as in *Barycrinus princeps*, *B. Hoveyi*, and other species. No pinules. Column pentagonal, composed near the head of thicker and thinner plates. Columnar canal large, pentagonal sides concave.

Collected, by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri. Only a single specimen was found, which is illustrated.

BARYCRINUS BLAIRI, n. sp.

Plate III, Fig. 11, side view of a crushed specimen showing part of the arms; Fig. 12, side view of a calyx; Fig. 13, azygous view of the same specimen.

Species robust. Calyx wider than high, plates sculptured; depressed between the radials, sutures distinct, angles of the plates sunken. Basals forming a low pentagonal cup, with angles moderately high between the subradials, and a concave depression at each longitudinal suture similar to that in *Barycrinus Boonvillensis*, and having a stellate outline as seen from below. Subradials large, hexagonal, except the one on the azygous side, which is heptagonal, a little wider than high; surface stellate with the highest point in the center and ridges extending to each adjoining plate. First radials of unequal size, wider than high, pentagonal, sculptured, having a ridge extending from the central part to each subradial below, rounded in the upper part, and truncated nearly the entire width above, so as to present a broad concave facet for the reception of the brachials. Brachials two in each ray, wide, rounded, thin, the second one being a little thicker than the first and axillary. Arms coarse, rounded externally, the right arm in the ray opposite the azygous side bifurcates again on the second plate, the other arms, in our specimen, are not preserved so as to show whether or not there are any other bifurcations, but branchlets or armlets are given off at intervals in all the arms. The first azygous plate is rather large and truncates a subradial, the second one is injured in our specimen so that the outline cannot be ascertained. Portions of the vault show that it was covered by numerous minute, almost granular plates. Column pentagonal.

Collected, by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri.

BELEMNOCRINUS SAMPSONI, n. sp.

Plate III, Fig. 8, side view, showing part of the arms.

Calyx elongated, somewhat obconoidal, more than twice as high as wide, constricted at the top of the basals, truncated at the base where it rests upon the column, sutures distinct, surface smooth or finely granular. Basals five, three times as long as wide, very slightly expanding, and forming a sub-cylindrical cup. Radials five, shorter than the basals, rapidly expanding, longitudinally convex, truncated half the width above, for the articulation of the free arms, and sloping from the articulating facets to the sutures. Arms large, round externally, plates long, and the two seen in our specimen bifurcate on the fourth plate and in one of them the second plate in each arm above the bifurcation projects and supports a pinnule. Column obscurely pentagonal, composed of thicker and thinner plates and showing externally the serrations from the radiating furrows on the faces of the plates. The first plate at the head of the column is thicker and stronger than any below.*

Collected, by F. A. Sampson, in the Burlington group, at Sedalia, Missouri.

DICHOCRINUS HUMBURGI, n. sp.

Plate III, Fig. 9, side view of a specimen which is depressed; Fig. 10, view of the azygous side of the same specimen.

Calyx somewhat obconoidal, truncated below; surface granular. The two basals form a cup a little less than half the length

* It may be proper here to state, that Meek & Worthen erroneously described *Belemnocrinus Whitii*, as possessing basal and sub-radial plates, and their erroneous illustration was reproduced by me, in *North American Geology and Palæontology*, page 229. The five small central plates, in their diagram, have no existence whatever, but instead thereof, the ends of the basal plates bear a short foot-like internal projection, which rests upon the first plate of the column, and points of these foot-like projections are prevented from uniting by the perforation for the columnar canal.

of the calyx, which is truncated and concave below; the column has a diameter equal to about half the diameter of the truncation and a narrow circular depression surrounds it; the notch, at the union of the basals, at the top, is hardly discernible on either side. First radials about one-half longer than wide, and expanding very slightly; the upper face of each radial is concave nearly the entire width for the reception of the brachials. Brachials, one in each series, thin and axillary. The arms bifurcate on the second plate, giving to the species twenty arms, which, so far as preserved in our specimen, consists of a single series of plates rounded externally. First azygous plate very little smaller than a first radial and contracted toward the upper end instead of expanding as is usual in this genus.

Collected, by R. A. Blair, in the Keokuk group, at Boonville, Missouri. Only one specimen was found, which is illustrated. The specific name is in honor of H. H. Humburg, an active collector at Boonville, Missouri.

DICHOCRINUS PARVULUS, n. sp.

Plate IV, Fig. 7, azygous view; Fig. 8, opposite view of another specimen.

Species small. Calyx a little higher than wide, somewhat obconoidal; sutures slightly depressed so as to give a little convexity to the plates; surface granular. The two basals form a short obconoidal cup, about twice as wide as high, pointed to the small column below; the notch at the top of the union of the basals on the azygous side a little deeper than it is on the opposite side. First radials about one-half longer than wide, increasing in width toward the upper end, which is truncated so as to show a broad slightly concave facet for the first brachials. One brachial in each ray, which occupies about three-fourths of the width of a radial, height about half the width and bearing upon the steep upper sloping sides the free arms. Arms ten, rounded externally and composed of a single series of thin plates. Pinnules thick and closely packed together on both sides of the arms. First azygous plate a little narrower than a first radial, and very

slightly expanding upward; the succeeding plates form an arch extending over the vault. Column round, at the calyx.

Collected, by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri.

ZEACRINUS POCILLUM, n. sp.

Plate IV, Fig. 2, azygous side, the arrangement of the seven plates in the area are not indicated in the figure; Fig. 1, opposite view of same specimen.

Calyx very low, disk-like, broadly and deeply sunken at the base so that the bottom of the cup is on a line with the top of the calyx; surface granular. Basals forming a pentagonal disk nearly covered by the small column. Subradials small, one-half within the basal cavity, the other half curved upward on the outside, and forming an angular rim. First radials about two and a half times as wide as high, the upper truncated side being the longer one and separated from the brachials by a gaping suture. There are two slightly constricted brachials in each ray, the second one of which is axillary, except in the ray opposite the azygous side, which is truncated on top and followed by five single plates before the bifurcation takes place. There is only one bifurcation of the arms, which gives to the species eighteen arms. The plates are long and slightly cuneiform, the axillary ones being quite tumid. Pinnules long and coarse. Azygous area wide, convex, exposing seven plates, alternately arranged, the first one resting between the upper sides of the subradials and the under sloping side of the first radial on the right, the second one slightly truncating a subradial and in one specimen does not touch it. Column small, round.

Collected by R. A. Blair in the Keokuk group, at Boonville, Cooper county, Missouri.

CYATHOCRINUS BOONVILLENSIS, n. sp.

*Plate IV, Fig. 3, azygous side, showing arms, specimen slightly crushed;
Fig. 4, opposite view of a specimen showing part of the column, and
stronger surface ornamentation.*

Calyx low, bowl-shaped, more than twice as wide as high, base deeply depressed, plates sculptured, sutures between the subradials depressed so as to give the calyx a subpentagonal outline, when viewed from below. Basals forming a pentagonal disk one-half wider than the column, and situate within the basal depression. Subradials large, curving into the basal cavity to meet the basals and bending upward so as to form half the calyx, each one has a central conical point from which small well defined ridges radiate to each adjoining plate. First radials wider than high, with a ridge extending from the brachials to each abutting subradial, and a concave facet more than one-third the width of the plates for the articulation of the brachials. Brachials two, the first one thin, the second longer and having steep upper sloping sides. Arms spread from the second brachials, at an angle of forty-five degrees or more, and throw off arms, from the inner side, that stand upright, some of which bifurcate. Each arm on the left of the azygous plate, in one of our specimens, throws off four arms from the inner side, the first three of which spring from every second plate, the other is more distant, the first one bifurcates three times, the second and third bifurcate twice. The other rays appear to bear the same number of arms, thus making sixty arms in this species. The lower parts of the arms are somewhat angular externally, but higher up they are round and composed of long joints without pinnules. The first azygous plate is hexagonal, truncates a subradial, extends as high as the radials, bears a prominent central ridge and is followed by three plates, one in the central part and the others supported laterally upon it and the primary radials. Column round and composed of thicker and thinner plates.

Collected by R. A. Blair in the Keokuk group, at Boonville, Cooper county, Missouri.

POTERIOCRINUS BRITTSI, n. sp.

Plate IV, Fig. 6, azygous side; Fig. 5, opposite view.

General form sub-cylindrical, when the arms are closed but constricted around the brachials. Calyx obconoidal, height and width subequal; plates rounded, granular, sutures distinct. Basals pentagonal, standing nearly upright, forming a rim around the column, within which the basals are flattened and radially furrowed for the attachment of the column. Subradials hexagonal, rather longer than wide. Primary radials pentagonal, wider than long, upper side truncated the entire width for the support of the brachials and having a gaping suture. Brachials about as long as wide, rounded and constricted in the middle. Three of the first arm plates are twice as long as wide and axillary which gives to the species sixteen arms. The arms are long, flattened on the sides so as to permit them to close tightly together, and composed of long, slightly cuneiform plates. Column round. Azygous area is injured in our specimen and the vault and pinnules are not observed.

Collected, by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri. The only specimen found is illustrated. The specific name is in honor of Dr. J. H. Britts of Clinton, Missouri, a member of the Geological Board of the State.

CYATHOCRINUS SAMPSONI, n. sp.

Plate IV, Fig. 10, azygous view; Fig. 9, opposite view.

Calyx obconoidal, longer on the azygous side than on the others; beveled at the sutures; surface smooth or granular. Basals forming a low pentagonal cup, depressed at the sutures on top so as to give it a zigzag outline; sutures between the basal plates not beveled; truncated at the bottom only the size of the column; columnar cavity of moderate depth. Subradials hexagonal, longer than wide, except the one on the azygous side which is heptagonal, larger than either of the others, and fully

as wide as long, all of them gradually expanding to the lateral angles. First radials, rather longer than wide, lateral sides straight, protuberant at the arm facets, indented for the arm furrows upon the upper margin; articulating facets somewhat circular extending down two-thirds the length of the plates, and occupying nearly the entire width above, and bordered by an elevated rim. Azygous plate sub-quadrate and two-thirds as large as a first radial. Column small, round.

Collected, by F. A. Sampson, in the Burlington group, at Sedalia, Missouri.

MISSOURICRINUS, n. gen.

(*Ety*, proper name; *krinon*, a lily.)

Calyx obconoidal or basin-shaped. Basals five forming a small cup. No subradials; no regular interradians. Primary radials one by five, wider than high, and separated from the brachials by an external gaping suture. Brachials axillary except in the ray opposite the azygous side. Arms resembling those in *Scaphiocrinus*. First azygous interradian rests between two primary radials and truncates a basal plate. Column pentagonal.

The formula of this genus is much like the Lower Silurian *Heterocrinidæ* and *Anomalocrinidæ*. That is, the genus has five basals, no subradials, no regular interradians, but azygous interradians. The brachials and arms remind one of the *Potriocrinidæ* and the azygous plate of the *Cyathocrinidæ*. The affinities are nearest the *Heterocrinidæ*; but I think a new family should be formed for it. Type *M. admonitus*.

MISSOURICRINUS ADMONITUS, n. sp.

Plate IV, Fig. 12, azygous view; Fig. 11, opposite view.

Calyx obconoidal, rapidly expanding, twice as wide as high, slightly longer on the azygous side than on the others; surface

smooth or granular. Basals forming a low cup; plates pentagonal, except the one on the azygous side, which is larger than the others and hexagonal by reason of being truncated on top. Each plate has a shortfoot-like projection internally against which the column abuts. First radials, expanding, pentagonal, twice as wide as long, and truncated the entire width above for the articulation of brachials, and separated externally from them by a gaping suture. Brachials pentagonal, constricted on the sides, and bearing upon the upper sloping faces the free arms, except the one opposite the azygous side, which is quadrangular and bears a single arm. Arms, as shown in our specimen, nine, composed of cuneiform plates alternately projecting on the sides for the support of pinnules. Azygous plate more than twice as long as wide, rests upon the truncated end of a basal plate, between two radials and curves over to meet the plates of the vault. Column pentagonal and having short radiating denticulations within the border of the articulating faces of the plates.

Collected, by F. A. Sampson, in the Burlington group, at Sedalia, Missouri.

SYNBATHOCRINUS BLAIRI, n. sp.

Plate IV, Fig. 15, azygous side with column; Fig. 14, opposite view; Fig. 13, top of calyx.

Calyx like a small cup, a little wider than high, with sutures depressed, so as to give it a subpentagonal outline. Surface finely granular. Basals low, forming a pentagon with slightly concave sides, and having a rim that projects below the point of the attachment of the column. First radials quadrangular, arcuate below, nearly as wide as high and slightly beveled at the sutures. Brachials smaller than the radials, length and width nearly equal, the two adjoining the azygous plate longer than wide and the others as wide or wider than high, sharply angular longitudinally. The sutures between the radials and brachials are beveled so as to give the top of the calyx a pentagonal outline. The first azygous plate is about two and a half times as

long as wide, rests in a notch between two radials, truncating the one on the right more than the one on the left and extends beyond the brachials to near the middle of the first arm plate. The second plate exposes only a short triangular area. The arms are long, sharply angular longitudinally, with a deep ambulacral furrow within and are composed of thirty-five or forty quadrangular plates. Proboscis about the same size as an arm. Column round.

Collected by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri.

ACTINOCRINUS NODOSUS, n. sp.

Plate V, Fig. 7, specimen on a slab, depressed and showing a few vault plates.

Calyx large, obconoidal or somewhat urn-shaped; about as high as wide, ornate; all the plates bear central, abrupt, more or less transverse prominences, that do not slope off toward the sutures, as the nodes do in all other species, known to the author, beside being connected with each other by short angular ridges that give the surface of the plates a somewhat stellate appearance; plates indented at the angles. Basals form a low cup broadly truncated below for a large round column, the plates have a foot-like projection internally to which the column is attached; they are pentagonal, twice as wide from one lateral angle to the other as high; three small ridges extend from three little nodes, at the lower edge of the basals up to three small nodes, on three of the first radials, near the base of the transverse prominences; from the base at the sutures a furrow runs up to the transverse prominence on two of the radials and on the first azygous plate and on each side of these furrows there is a smaller one. First radials large, wider than high, three hexagonal and two heptagonal. Second radials hexagonal, wider than high and about two-thirds as large as the first. Third radials somewhat larger than the second, four of them hexagonal and the one on the left of the azygous side octagonal, and bear upon

their upper lateral sides the secondary radials. Secondary radials hexagonal, less than half the size of the third radials and bear upon their upper sloping sides tertiary radials. The calyx has twenty arm openings. Inter-secondary radials two, one hexagonal, elongated, truncates the third radial; it is followed by a narrow plate between the tertiary radials which connects with the plates of the vault. Regular interradians eight or nine, the first one as large as the second radials, two smaller ones in the next range, followed by two in the next and these are followed by three or four small plates, in line, before they meet the plates of the vault. Azygous area much larger and containing twelve or fourteen plates; the first one is in line with the first radials and of the same size, there are two in the next range, three in each of the next two ranges, and above these the number cannot be accurately determined from our specimen. Vault highly convex and covered with tumid and spinous plates. Proboscis unknown. Columnar canal pentagonal.

Collected by R. A. Blair, in the Burlington group, at Sedalia, Missouri. Only a single specimen was found, which is illustrated.

DORYCRINUS CONFRAGOSUS, n. sp.

Plate V, Fig. 12, view of the azygous side; Fig. 13, view of the opposite side.

Calyx bowl-shaped, interradian areas depressed in the upper part so as to form a sub-pentagonal outline at the arm bases; sutures depressed; plates thick, convex; surface granular. Basals very low, truncated, broad, more than six times as wide as high, deeply excavated for the columnar attachment, showing the plates form a cone in the interior of the calyx extending higher than the exterior; plates thick and deeply notched at the sutures. First radials large, rapidly expanding to the lateral angles, one-half wider than high, three hexagonal and two heptagonal, the lower angles of the latter reach almost to the base of the calyx. Second radials quadrangular, more than twice as wide as high. Third radials a little larger, pentagonal,

twice as wide as high, and each supports on its upper sloping sides two secondary radials, each of which is more than twice as wide as high, and the second one is axillary and supports upon each of its upper sloping sides, two, wide, thin, tertiary radials. There are twenty arm openings to the body. First regular interrarial very large, decagonal, it is followed by two plates, the one on the right being the longer one and reaching high between the tertiary radials. Azygous area large; first plate larger than a first radial, wider than high; it is followed by three large plates, two of which support tertiary radials on the left and the other supports the tertiary radials on the right; the central plate and the one on the right support four plates, the lateral ones being quite small, and these are followed by two or three series of vault plates, which stand nearly perpendicular, before reaching the plates that surround the azygous opening. Vault elevated highly convex, depressed toward the interrarial area so as to be somewhat five-lobed, and covered with convex and tumid polygonal plates, that extend out over the base of the arms, the larger and more tumid plates being over the radial lines except the large, subcentral, tumid octagonal plate, that is above and behind the azygous opening.

Collected by F. A. Sampson, in the Burlington group, at Sedalia, Missouri.

DORYCRINUS AMÆNUS, n. sp.

Plate V, Fig. 6, azygous view; Fig. 5, side view.

Body small, rotund. Calyx cup-shaped, one half wider than high; vault convex, arms spreading; plates smooth or finely granulous. Basals spreading, four times as wide as high, and having a small rim projecting below the end of the column; columnar cavity round and radiately furrowed. First radials very large, three hexagonal and two pentagonal, wider than high, spreading from the basals up. Second radials small, quadrangular, twice as wide as high, sometimes anchylosed with the third radials. Third radials heptagonal, the superior lateral angles

being slightly truncated by interrarial plates; twice as wide as long, and each supporting upon the upper sloping sides two secondary radials; one in each posterior lateral ray being axillary and supporting tertiary radials, making twelve arm openings in the body. Interrarial areas depressed, concave, giving the upper part of the calyx a subpentagonal outline. First interrarial plate large, octagonal, supporting two rather long plates which unite with the plates of the vault. First azygous plate as large as a first radial, heptagonal, and supports three rather large plates which are followed by a row of five plates, two of which support arm plates and three unite with the smaller plates of the vault, which are followed by one or two series of small plates that surround the azygous opening. Lower part of the azygous opening about on a line with the top of the plates, that cover the arm openings. Vault covered with smooth, polygonal plates, that extend out over the base of the arms and increase in size toward a large subcentral, tumid, heptagonal plate, that is above and behind the azygous opening.

Collected by R. A. Blair, and F. A. Sampson, in the Burlington group, at Sedalia, Missouri. The specimen figured is from Mr. Sampson's collection; Mr. Blair's collection contains only a single inferior specimen.

ZEACRINUS COMMATICUS, n. sp.

Plate V, Fig. 10, azygous side; Fig. 11, opposite view.

Calyx low, basin-shaped, obscurely pentagonal, three times as wide as high, deeply sunken at the base; the angularity of the brachials give a sub-pentagonal outline to the top of the calyx; surface granular. Basal disk one-half larger than the diameter of the column. Subradials abruptly curving down into the basal cavity and bending upward half the height of the calyx.

First radials about twice as wide as high, with a transverse gaping suture between them and the brachials. There are two brachials in the ray opposite the azygous side and one in each of the other rays; they are slightly constricted in the middle part.

The first bifurcation of the arms generally takes place on the sixth plate, but in some arms it takes place on the third, and in others on the tenth plate, hence there is no absolute uniformity in this respect, in different specimens. There are four arms thrown off from each of the inner sides of the main arms, except in the ray opposite the azygous side, which only throws off two; hence, there are forty-six arms in this species. The plates are thin and cuneiform, except the axillary ones, which are thick and prominent, giving the arms a knobby aspect. Pinnules thick, dense, and composed of ten or more pieces. Azygous area convex, exposing seven plates alternately arranged, the first one resting between the upper sides of subradials and the under sloping side of the first radial on the right, and the second one truncating a subradial. The top of the proboscis is enlarged, convex, and covered with tumid and conical almost spinous plates. Column round.

Collected by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri.

SCAPHIOCRINUS BOONVILLENSIS, n. sp.

Plate V, Fig. 1, lateral view, with azygous side on the left; Fig. 2, opposite view.

Calyx low, pentagonal, saucer-shaped; plates thick, deeply sculptured. Basals extending but little beyond the column, subradials about as wide as high, tumid in the central part and having strong ridges radiating to each adjoining plate. Radials twice as wide as high, truncated the greatest width of the plates for the brachials, and having wide, downward sloping, gaping sutures terminating in a ridge on each plate, with two ridges below extending laterally from it to the adjoining subradials. Brachials two in each series, the first quadrangular, more than twice as wide as high, constricted on the sides, leaving a sharp, central, longitudinal ridge and a ridge at the upper and lower margin; sutures gaping. Second brachials axillary and having a longitudinal ridge and one at each of the upper margins and

one at the lower margin. Arms very rough, plates constricted, the first division takes place on the sixth plate and above this there are two arms thrown off from the inner side of each arm, as in *Zeacrinus*, which gives forty arms to the species. The axillary plates are tumid and sculptured. Pinnules long and coarse. Azygous area large, subovate, plates sculptured, alternately arranged, the first one resting between two upper sides of subradials and the second one truncating a subradial, as is usual in this genus. Proboscis flat and composed of hexagonal plates in longitudinal series, sculptured and highly ornamental. Column small, pentagonal.

Collected by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri.

SCAPHIOCRINUS CONSTRICTUS, n. sp.

Plate V, Fig. 4, azygous view; Fig. 3, opposite side.

Calyx low, pentagonal, cup-shaped; plates thick, sculptured. Basals extending slightly beyond the column. Subradials tumid, sculptured, sutures depressed. Radials two and half times as wide as high; sutures gaping with a projecting rim near the upper margin. Brachials two in each series, the first one quadrangular, more than twice as wide as high, constricted in the middle, the second one axillary, constricted. The first bifurcation takes place on the sixth plate in some arms and the eighth plate in others, and above this there are two arms thrown off on the inner side of each ray, making forty arms in the species. All the arm plates are constricted and flanged at the upper edge. Axillary plates tumid. Pinnules coarse. Azygous area elongate, first plate between upper sloping sides of subradials; second plate truncating a subradial and plates alternately arranged as in other species in this genus. Column pentagonal. This species is distinguished from *S. Boonvillensis*, by the larger size, nearer equal bifurcation of the arms, greater length to the first bifurcation, and by the sculpturing on the plates of the calyx. Proboscis unknown.

Collected by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri.

RHODOCRINUS PARVUS, n. sp.

Plate V, Fig. 8, azygous view; Fig. 9, opposite side.

This is a small species. Calyx globular, contracted at the base of the arms, a little wider than high; sutures distinct, sunken at the angles; plates sculptured and more or less well defined ridges extend from the central part of each plate to each adjoining one. Basals small, extending but little beyond the column. Subradials hexagonal, the largest plates in the calyx, highly convex in the central part with ridges extending to each adjoining plate. First radials nearly as large as the subradials, heptagonal, highly convex in the central part, with ridges extending to each adjoining plate, the larger one reaching the second radial. Second radials smaller than the first, quadrangular in some cases and hexagonal in others, by reason of a slight truncation of the upper angles by the third range of interradians. Surface ornamentation same as on the other plates. Third radials smaller than the second, axillary, and supporting upon the upper sloping sides a single brachial, which is followed in some rays by four and in others by five arm plates, before a bifurcation takes place. Above this bifurcation there are ten arms, a few plates are single, and then the arms are composed of a double series of plates. Arms, round, externally, and bear numerous strong pinules compacted together on both sides. Regular interradians eight, the first one truncates a subradial, there are two in the second range, three in the third and two in the fourth which unite with the plates of the vault. Azygous area wider than the regular interradian areas, the first plate larger and above this the plates more numerous. Column round and composed near the head of thicker and thinner plates. Columnar canal small, round.

Collected by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri.

FORBESOCRINUS ELEGANTULUS, n, sp.

Plate V, Fig. 14, azygous side; Fig. 15, opposite view. There should be four primary radials shown in the figure in the front series instead of three.

This is the smallest known species. Calyx pentagonal when viewed from below; surface granular. Basals substantially covered by the column. Four of the subradials are small, subtrigonal in outline, the lateral angles being only slightly truncated, the other one is large, extends as high as the first radials and supports three interrarial plates. Primary radials four, in each series, sub-angular longitudinally, the first one is the largest plate in the calyx, wider than long, hexagonal; the second plate is short, wide and hexagonal; the third is very short and quadrangular, the fourth is pentagonal and axillary. Secondary radials three in each series, a little smaller than the primary radials and gradually tapering. Tertiary radials five or six in each series, small; sutures sinuous. The arms are round and again divide, making forty arms in the species. Interrarial areas sub-ovate, depressed and occupied by about ten or twelve plates. Azygous area wider than the regular areas and occupied by twenty-four or more plates, three of which rest upon a sub-radial and the one on the right bears a straight series of eight plates or more. Intersecondary areas occupied by five or more plates. Intertertiary plates one or more. Column near the head tapering downward and composed of thin plates which are radiately furrowed near the outer rim.

Collected by R. A. Blair, in the Keokuk group, at Boonville, Cooper county, Missouri.

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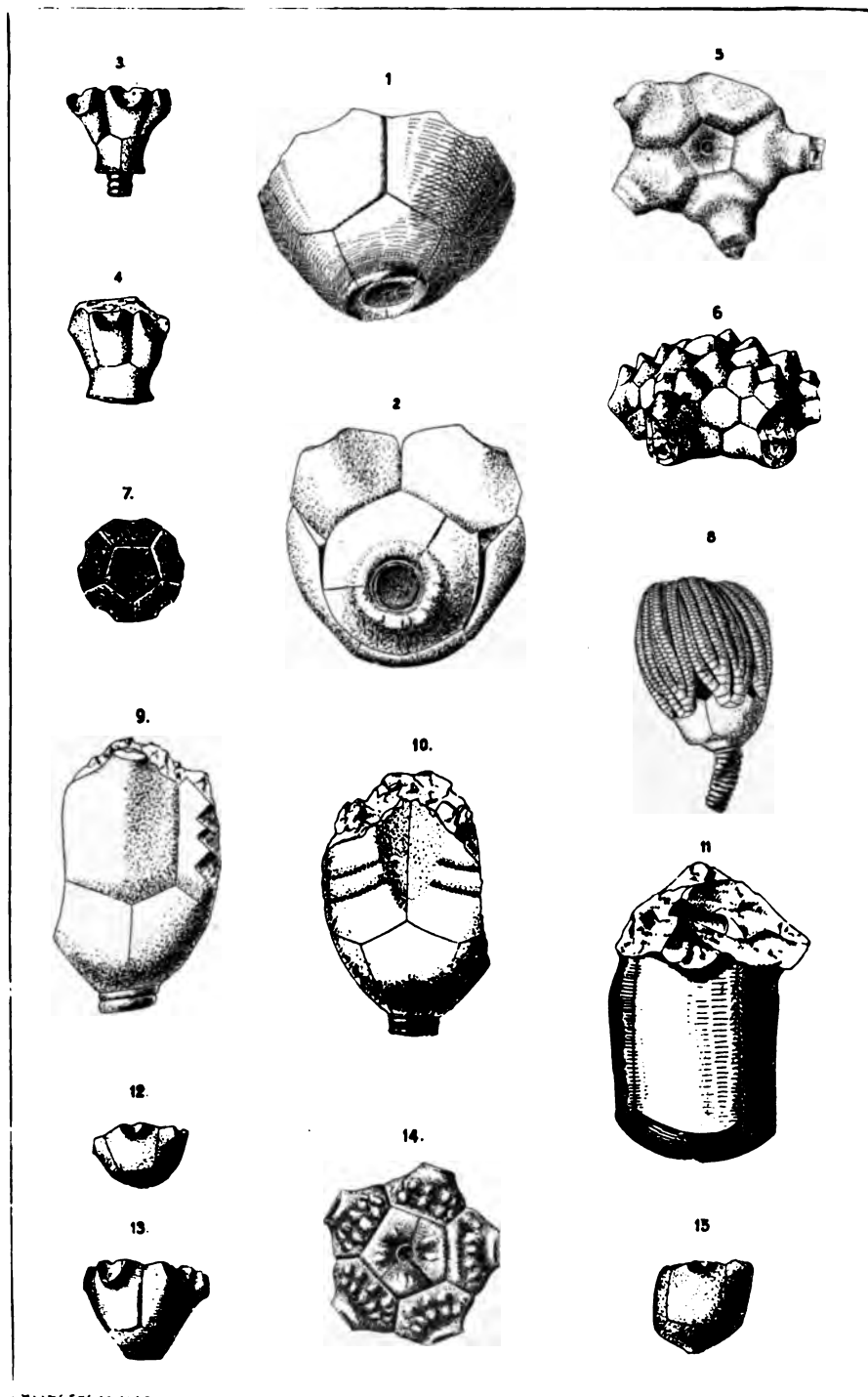


PLATE I.



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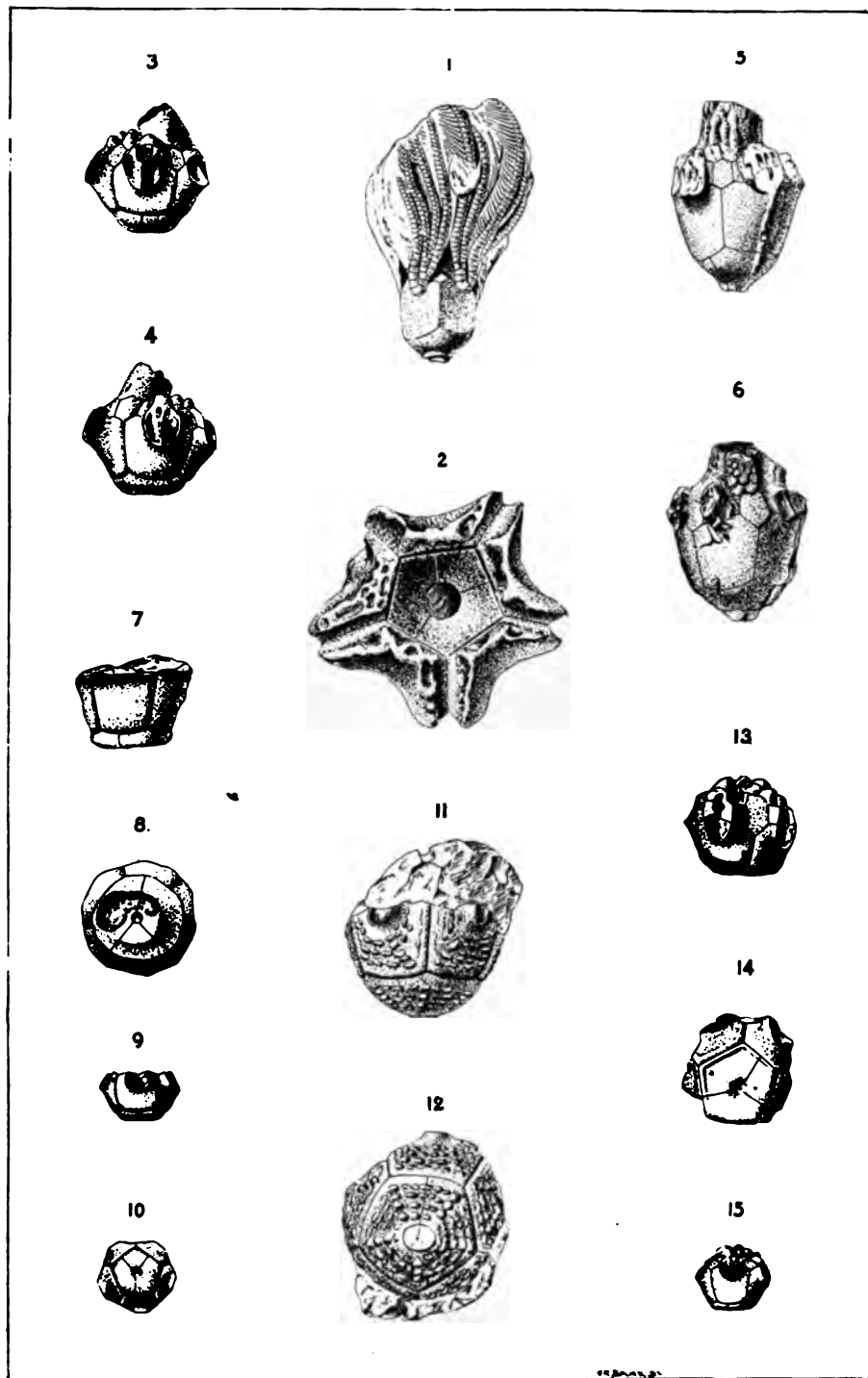


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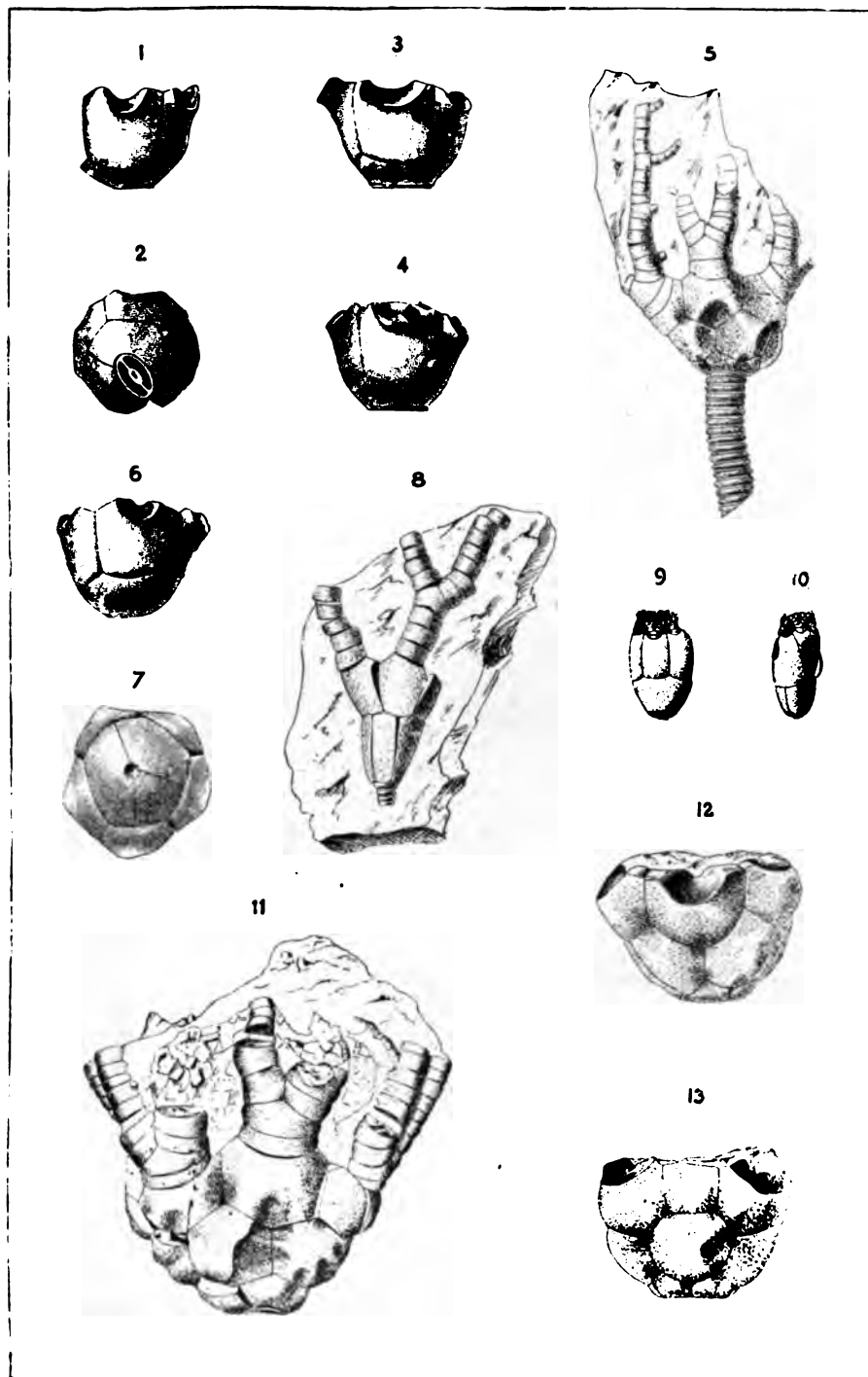


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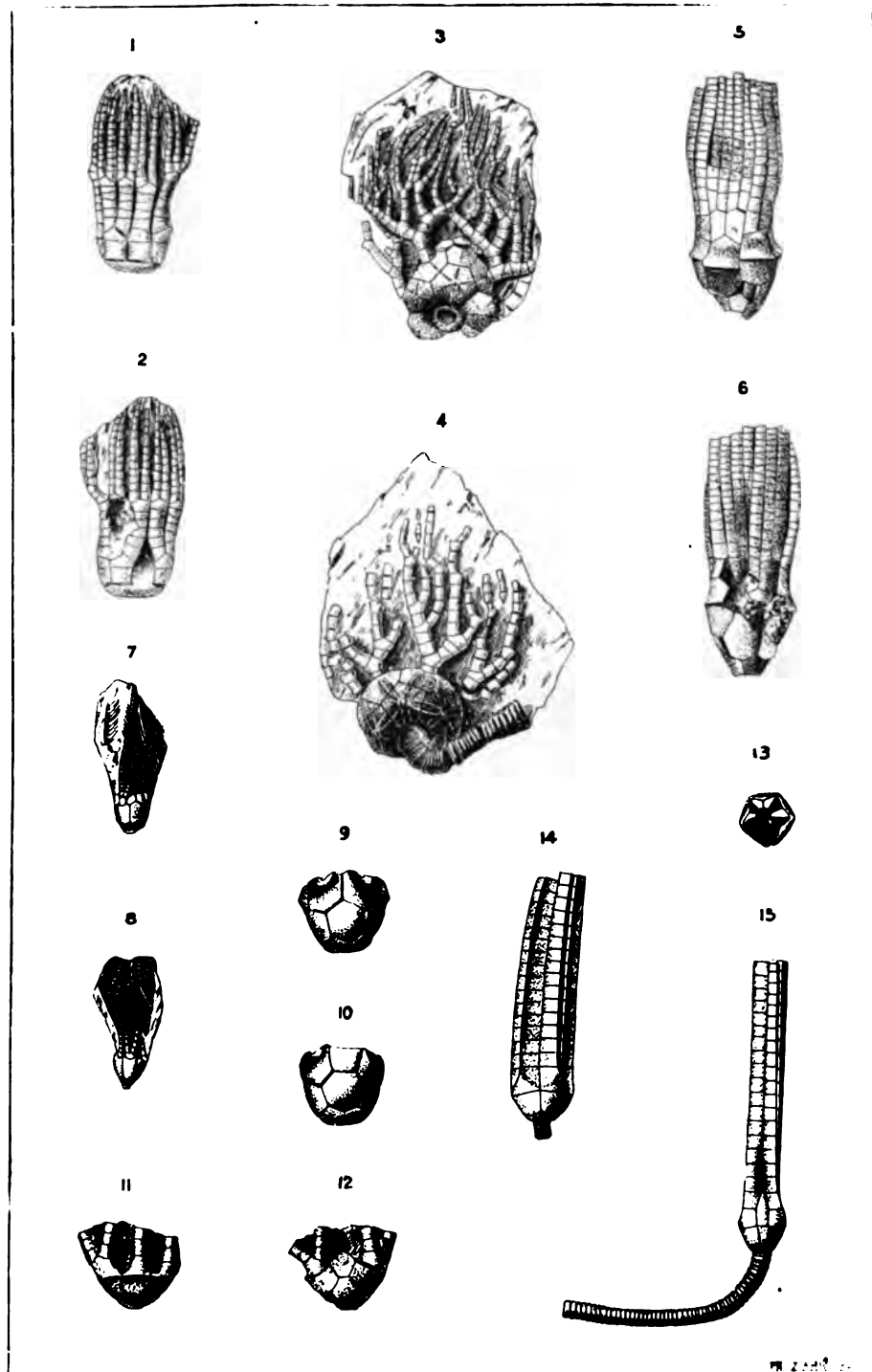


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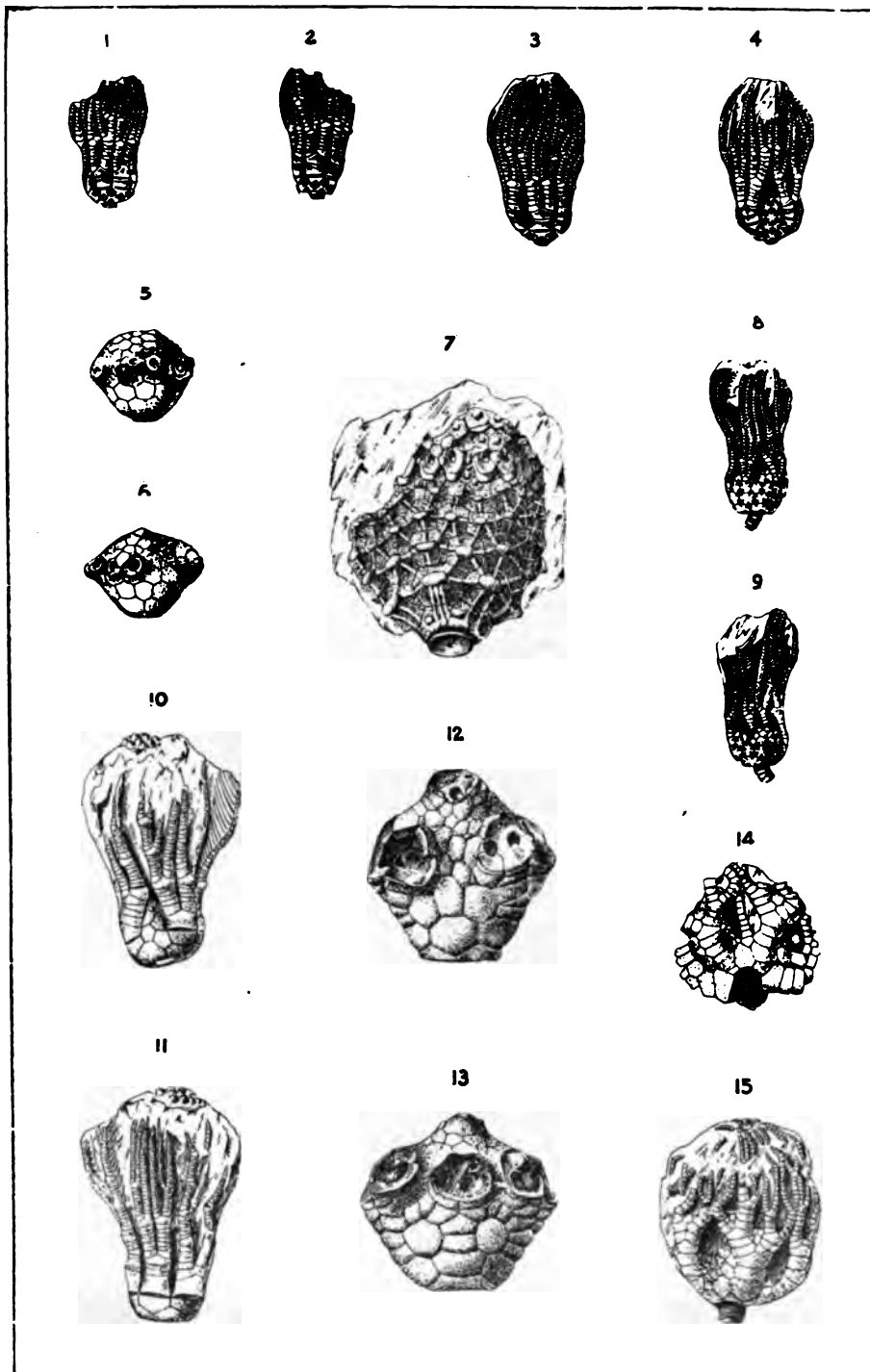


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GEOLOGICAL SURVEY OF MISSOURI.

ARTHUR WINSLOW, STATE GEOLOGIST.

BULLETIN NO. 5.

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PUBLISHED BY
THE GEOLOGICAL SURVEY.

JEFFERSON CITY,
JULY 1892.



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ARTHUR WINSLOW, STATE GEOLOGIST.

BULLETIN No. 5.

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ARTHUR WINSLOW, STATE GEOLOGIST.

BULLETIN No. 5.

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GEOLOGICAL SURVEY OF MISSOURI.

BULLETIN NO. 5.

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**THE AGE AND ORIGIN OF THE
CRYSTALLINE ROCKS OF MISSOURI.**

By ERASMUS HAWORTH.

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PREFATORY REMARKS.

The crystalline rocks of Missouri occur exclusively in the south-eastern portion of the State. They are abundantly exposed in Madison, Iron and St. Francois counties; but they are also found, though less frequently, in at least eight other counties of this section of the State. They constitute the mass of the rugged hills and mountains of Iron and Madison counties and elsewhere their characteristic occurrence is in similar hills surrounded by limestone valleys. These are truly ancient elevations, older than any others in the State, older than the mountains of Arkansas, older than the Appalachians, older than the Rocky Mountains; if venerable be an attribute of great age they certainly merit that appellation. And not only are all other rocks of Missouri youthful as compared with these, but there is a genetic relationship and the former are in a sense descendants of the latter. For, when the limestone and other sedimentary rocks were yet unformed, these crystalline rocks must have existed as parts of a continental mass, and from the degradation of this continent resulted the materials of the later formed sedimentary rocks. The present granite and porphyry hills are but protruding parts of the remnant of this ancient continent which stood as islands above the ocean waters while the beds of limestone and sandstone were being formed around them; which rose with these beds when they were lifted from the waters; which now, rugged and weather-beaten, yet tempered by age and varied experience, rear themselves above the surrounding younger rocks and bid fair still to live when the latter have yielded to the forces of degradation.

The question of the origin of these rocks has, heretofore, never been made a subject of such exact study as modern methods call for and as its importance justifies. Swallow,¹ while recognizing the granites and the porphyries as igneous rocks, presents little or no demonstration in support of this view, and, further, he classes, as metamorphosed slates and conglomerates, rocks which the present work shows cannot be separated from the porphyries. Other writers seem to have substantially

¹ Second Annual Report. By G. C. Swallow, State Geologist, 1854, pp. 133 to 135.

accepted this conclusion in a large part, but Pumpelly² expands upon it and applies the hypothesis of metamorphosis to all of the Missouri porphyries.

Mr. Haworth's study of these rocks began in the summer of 1886, and he has ever since pursued the subject with zealous yet patient enthusiasm. This he has done partly at his own instance, partly in the interests of the National or State Geological Surveys, but always without pecuniary gain. Hence this Survey, though fortunate in gleaning the results of his years of study, is also under obligations to him for this contribution.

The association of iron ores with these rocks brings the question of the origin of the latter into direct economic importance; for the distribution of these ores is fundamentally dependent upon this question. Exploration for, or development of such ore bodies based upon wrong theory must invariably lead to profitless expenditure.

In connection with this, as well as other work in south-eastern Missouri the Survey is indebted for assistance, guidance and cordial reception to many citizens and especially to Prof. Wm. B. Potter, engineer of the Iron Mountain Company, to Mr. Crain, superintendent at Pilot Knob, to Mr. Thos. Beard, Dr. T. R. Goulding and Mr. Richard Payne of Ironton.

ARTHUR WINSLOW,
State geologist.

² Report on the Iron Ores and Coal Fields of Missouri. By Raphael Pumpelly, State Geologist, 1873; pp. 3 to 28.

THE AGE AND ORIGIN OF THE CRYSTALLINE ROCKS OF MISSOURI.

BY ERASMUS HAWORTH.

INTRODUCTION.

The following paper embodies the more important results obtained from a somewhat extended examination of the crystalline rocks in the vicinity of Pilot Knob. Field work and laboratory examination with the microscope and otherwise were alternated so that they mutually supplemented each other. The conclusions drawn are somewhat at variance with those published by others who have worked in the same fields, in that all of the porphyries as well as the granites are held to be ancient eruptives, rather than metamorphosed sediments. Scope of work.

I acknowledge with gratitude the kindness of the State geologist, Mr. Arthur Winslow, and others for suggestions regarding the arrangement and the subject-matter of the paper; of Mr. Merriam, of Madison, Wisconsin, for the preparation of photomicrographs; and of Mr. G. E. Ladd, of the State Survey, for photographs taken in the field. Conclusions.
Acknowledgments.

THE AGE OF THE CRYSTALLINE ROCKS.

All geologists, so far as the writer is informed, who have studied the crystalline rocks of Missouri, agree in pronouncing them Archæan in age. The publications on this subject are so numerous that it is not thought necessary now to give exact references to them. The facts heretofore adduced in support of this are, in brief, the superposition of the stratified Lower Silu- Age accepted as Archæan.

Archaean age
confirmed.

rian rocks, and the evidences of extensive erosion of the crystalline rocks before the deposition of these strata. The evidence gathered by the present State Geological Survey agrees substantially with that of former publications, and the question is again considered here largely for the sake of completeness, but also for the purpose of presenting some additional results of observation. These additional results may be included under the two following heads:

No contact
metamorphism
exhibited.

(1.) *Absence of contact metamorphism in the surrounding Palæozoic rocks.* The result of such action would undoubtedly be pronounced if, over so large an area, massive rocks had been erupted through the stratified ones. Not a single example of any thing which could at all be taken for contact metamorphism has been found anywhere within the area of the crystalline rocks, although the overlying stratified rocks are to be found in nearly every valley. When we consider that this area is several hundred square miles in extent this evidence becomes very strong.

Fragments of
crystalline rocks
in sedimentary
strata.

(2.) *Inclusion of numerous fragments of crystalline rocks almost everywhere in both sandstone and limestone.* Such fragments have been seen varying in size from almost microscopical dimensions to two or more feet in diameter. Fragments of porphyry are the more abundant, but those of granite are also known. This is the strongest proof adducible that the massive rocks are older than the stratified ones, for it is evidently impossible for these fragments of crystalline rocks to occur in the stratified rocks without having had an existence previous to the formation of the latter.

Occurrences of
included frag-
ments.

The localities where such occurrences can be found are numerous. Only a few of the more important ones will be mentioned. In section 1, township 33 N. 4 E., just west of the line between Iron and Madison counties, a ravine enters Stout's creek from the south. The creek valley is nearly a quarter of a mile wide on the south, and is so covered with soil that the rock formation cannot be seen. Farther up this ravine high porphyry hills form the walls on both sides of a narrow belt of stratified limestones and sandstone in the valley. On the west bank, in the limestone, is a large boulder of porphyry no less than eighteen inches in diameter. Farther up, in the sand-

stone, on the east bank, are several fragments of porphyry, one of which is fully twenty-four inches in diameter. A macroscopic and microscopical examination of these boulders show them to be practically of the same material as the porphyry in the hills on either side of the ravine. As they are not water-worn it is quite evident that they simply rolled down the hill-sides during the formation of the fragmental rocks, became imbedded in the strata, and afterwards were exposed by the erosion of the ravine.³

In section 35 of this same township a branch flowing west is lined with limestone. Just below where the county road crosses it, in the south-west corner of the section, the limestone in the bed of the creek resembles more a conglomerate than a limestone, on account of the great number of porphyry pebbles it contains. In section 3 of the same township, about two hundred yards south-east of Mr. Hutchins' house, the road to the Silver Mines crosses a little branch coming from the south-west which is lined with limestone. On the east of the crossing are high porphyry hills. The limestone at this place is filled with fragments of porphyry. About one hundred yards to the west Mr. Hutchins dug a well which penetrated the limestone fifteen feet or more. Scarcely a rock could be found thrown out in digging that did not have numerous fragments of porphyry in it. At his house is a well over two hundred feet deep bored with a diamond drill through limestone. The cores of this well for the last fifty feet or more show numerous fragments of porphyry. The St. Louis Ore and Steel Co., in prospecting in the vicinity of Pilot Knob, have used the diamond drill quite extensively. All of their borings in the valleys passed through limestone before entering the porphyry, and in every case porphyry fragments were found in great abundance in the lower portions of the limestone.

Occurrences of included fragments.

At Hutchins' house.

At Pilot Knob.

Further illustrations are hardly necessary, for similar examples are so numerous that even the casual observer may recognize them throughout the country.

³ These particular boulders were examined in 1888 and may have fallen from their resting-places by this time.

THE ORIGIN OF THE CRYSTALLINE ROCKS.

Sedimentary
origin previously
held.

Evidence now in-
dicates an erup-
tive origin.

Presumption
favors an eruptive
origin.

English views.

All publications on the subject of the origin of the crystalline rocks of Missouri are based on the assumption that they are, at least in part, highly metamorphosed sedimentary deposits. This idea has even crept into our text-books, so that short descriptions of Pilot Knob and Iron mountain, found here and there, universally assume that these hills are composed of metamorphosed clastic rocks. When this country was first visited by the writer, in the summer of 1886, he was well prepared to accept this view. Field work had not progressed very far, however, until serious doubts arose, for many points were noted indicating that all of these rocks were eruptive in origin, rather than sedimentary. Evidence in favor of this view continuously accumulated as the work advanced, until at present it seems advisable to place on record some of the more important facts bearing on the question.⁴

It may be stated in the beginning that the presumption is in favor of these rocks being eruptives, because it is becoming generally recognized that the felsites, and quartz and feldspar porphyries of various grades, and a large portion of the granite all over the world are eruptive rocks. The great majority of field geologists also treat them in the same way. It is believed that this is true with scarcely an exception, not only of American geologists, but also of the English and other Europeans. In Teall's work on "British Petrography" the assumption is made throughout the whole discussion of the felsites and porphyries that they are of eruptive origin. On page 291 we find the following: "Many of the felsites have been shown by Rutley and

⁴ The Geological Survey of Missouri now has in its possession a complete set of hand specimens, gathered with great care, from an area of considerably more than two hundred square miles, and maps and notes giving detailed descriptions of the rocks as they occur in the field. In addition to this, different members of the Survey have made excursions in many directions away from this area, gathering specimens and making notes, so that the material studied really represents a much larger area.

Bonney to be devitrified obsidians and pitch stones. Such felsites represent the glassy lavas of the earlier geological periods." Foreign views on the origin of porphyries. Rosenbusch's whole treatment of these rocks in his "Mikroscopische Physiographie der Massigen Gesteine" is based on the supposition that they are eruptives. Fouqué and Lévy treat the subject similarly in their work of 1879.

America has a great corps of active and able workers almost all of whom have come in contact with different felsites and porphyries similar to those of Missouri. Emmons and Cross have described those from around Leadville as eruptives.⁵ Hague American views. has described the porphyries of the Eureka District as eruptives;⁶ Irving has described those from the Lake Superior district as eruptives;⁷ Diller⁸ and Crosby⁹ have described those from near Boston as eruptives; Kloss describes porphyries from Taylor Falls, Minnesota, as eruptives.¹⁰

This list might be extended until it would include references to nearly all the felsites and porphyries of America, but it seems unnecessary to mention more.

It is thought best to divide the discussion of this subject into two parts, one of which deals with those phenomena and properties of the rocks that can readily be seen in the field; the other of which treats of properties that can be seen only by minute Order of discussion. examination, often with the microscope. Only a small proportion of those interested are so situated that they can make this latter examination. Therefore, at the expense somewhat of the logical arrangement of the subject-matter, the following outline will be followed.

A. FIELD EVIDENCE OF THE ERUPTIVE ORIGIN.

- (1). Absence of True Bedding.
- (2). Flow Structure, Banded Structure, and Lithophysæ.
- (3). Breccia.

⁵ Second Annual Rep. Director U. S. G. S., p. 221.

⁶ Third Annual Rep. Director U. S. G. S., p. 273.

⁷ Copper-bearing Rocks of Lake Superior, p. 91. See also pl. 12 and 13.

⁸ Bul. Mus. Comp. Zool. Harvard College, Vol. 7, p. 168.

⁹ Crosby at first held that the felsites near Boston were clastic, but later he entirely changed his views and now teaches that they are eruptives. Phys. Hist. of Boston Basin, p. 3 *et seq.*

¹⁰ Tenth Annual Rep. Minn. State Geologist, p. 188. See foot note.

- (4). Scoria and Amygdaloids.
- (5). Tuff.
- (6). Absence of Gradations of Crystalline into Noncrystalline Rocks.

B. PETROGRAPHIC EVIDENCE OF THE ERUPTIVE ORIGIN.

- (1). Texture of the Ground Mass in the Porphyries, and Breccias.
- (2). Flow Structure in the Porphyries and Breccias.
- (3). Broken Crystals due to Flowage of Lava after the Crystals were formed.
- (4). Magmatic Corrosion of Porphyritic Crystals and of Fragments in the Breccia.
- (5). Amygdaloids.
- (6.) Absence of Metamorphic Minerals.

A. FIELD EVIDENCE OF THE ERUPTIVE ORIGIN OF THE CRYSTALLINE ROCKS.

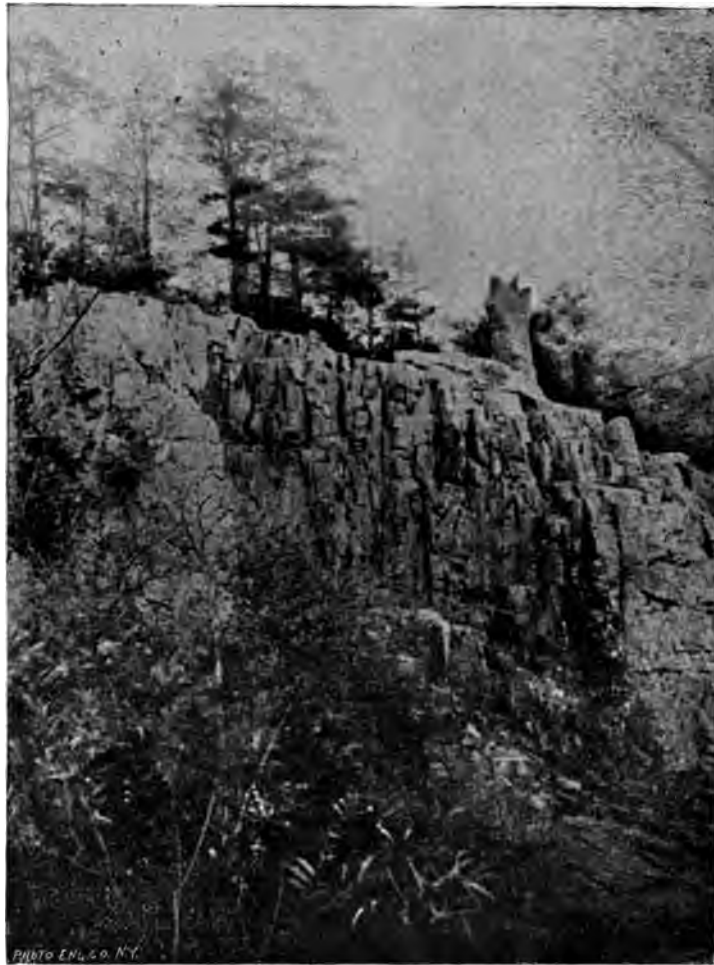
1. ABSENCE OF TRUE BEDDING.

Porphyries occur
massive in hills.

The porphyries and felsites of Missouri occur in a succession of steep, rugged hills entirely composed of massive rocks. Usually about two-thirds the way up the hill-side there is an almost precipitous wall, above which the inclination is not so steep, and below which the hill-side is covered with angular rock fragments, from the bluff above, to such an extent at times that grass can scarcely grow. The structure of the rock is almost everywhere decidedly massive.

Vertical fissures
in porphyry.

The porphyries are always greatly fissured, most frequently in vertical and horizontal directions, but occasionally in every direction. Sometimes these fissures are nearly parallel, in other places they cut each other at all angles. On the right bank of the Little St. Francois river, about three-fourths of a mile above its mouth, is a bluff of porphyry nearly a hundred feet high traversed by numerous vertical fissures, many of which not more than twelve inches apart can be traced from the top to the bottom of the bluff. At one place, on the top of the bluff, a column of porphyry about twenty-five feet high is left standing while a similar column has fallen by its side, but is still undecomposed.



View of porphyry bluff and needle showing vertical fissures and absence of bedding seams.

From right bank of Little St. Francois river, about 1 mile above the mouth. In S. E. quarter, sec. 24, township 33 N. 5 E.

Plate I, from a photograph, shows this bluff and column. It illustrates well the results produced by the vertical fissures, and exhibits a structure which does not differ very materially from the basaltic columnus so well known in other parts of the world. Similarly in nearly all of the other porphyry hills we see the same conditions only at times less perfectly and less extensively developed; great exposures of *massive* porphyries with no indications of true bedding. Occasionally the horizontal fissures predominate and give the rocks an appearance which might be mistaken for bedding structure if only a small area were studied. But such places are very few and are readily understood if careful examinations are made.

Vertical fissures
are frequent.

The Phenomena of Pilot Knob.

The rocks and associated ore of Pilot Knob perhaps have been most frequently referred to as presenting evidence of a stratified condition and they therefore deserve special attention here. It is, first, important that the reader should fully understand just what the conditions are at this place. Imagine a steep, conical hill rising more than 650 feet above the valley, a hill which stands out entirely alone excepting that a neck of ground on the east about 300 feet high connects it with other hills to the east. This is Pilot Knob. To the north, across a very narrow ravine, is Buzzard mountain. A limestone covered valley lies to the north-east. On the east and south-east are porphyry hills the rocks of which do not differ in any essential particular from those on the north side of Pilot Knob. A limestone covered valley touches the Knob on the south, west and north-west; on the south-west side of this valley is Shepherd mountain, and Cedar hill is on the north-west. Imagine, further, a plane inclined about thirteen ¹¹ degrees to the south south-west passing through this hill, about 150 feet below its summit, and you have the approximate location of the ore bed.

Pilot Knob a
porphyry hill
amid limestone
valleys.

Ore bed is an
inclined plane.

Fig. 1 shows Pilot Knob from a point to the west with the vertical wall on the north, the locations of the three tunnels,

¹¹ Pumpelly. Mo. Rep. 1872. I, p. 13.

Nos. 1, 2 and 3, the Simpson shaft, S, the approximate location and inclination of the ore bed, O—O, and several places on the hill-side, M, where massive rocks are exposed.

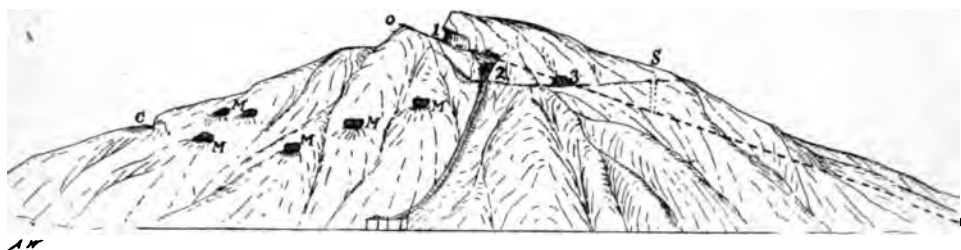


FIG. 1. Sketch of Pilot Knob showing the position of the ore bed, O—O, the cut on the north, the three tunnels Nos. 1, 2 and 3, the Simpson shaft, S, the cut east of the company's office, C, and several places where massive rocks are exposed, M.

The common explanation given is that the hill is composed of highly metamorphosed strata which have been faulted, the line of fault trending nearly east and west, with the south wall lifted enough to tilt the ore bed into its present position. When mining first began the ore bed actually projected to the north beyond the hill, on account of its resisting decay more than the rocks above and below it. The operators first cut away this projecting ore; then they followed it downwards into the hill, stripping the rocks from above as they went until they produced a high vertical face. Down the hill a short distance to the south-west they next drove a horizontal tunnel to the east. This is called Tunnel No. 1. Still farther down the hill in the same direction they drove Tunnel No. 2 directly east. After this they went down and around a little to the south-east, just at the head of a little ravine running south-westwards and drove Tunnel No. 3 to the north-east. They then went further around to the south-east, to a point nearly south of the summit, and sank a shaft known as the Simpson shaft. A little farther down the hill, to the south-west, another shaft, known as the air shaft, was sunk. The different tunnels were carried through the hill to the east side, and galleries were carried north and south connecting the tunnels and the shaft, and also reaching the open cut mining on the north. After all this was done the pillars were drawn, be-

Hill previously considered to be of metamorphosed strata.

Mining operations in the past.

ginning on the east. This allowed the hanging wall to fall and thus excellent outside exposures of vertical sections were made. This proceeded to such an extent on the east, north and west, that Tunnel No. 1 was finally completely exposed, and No. 2 was partially so on the west. In this way a vertical wall has been formed extending from Tunnel No. 2 around to the north and east forming approximately, an arc of a circle about 150° in extent. On the south hill-side are numerous large boulders that have fallen from the summit. The surface is otherwise so completely covered with the soil and small rock fragments that few exposures of the solid rock can be found. Such exposures, however, are very prominent at the air shaft, the Simpson shaft, and immediately above the mouth of Tunnel No. 3. In this last place the porphyry is badly decomposed, but the original structure with the vertical fissures can be readily seen. A photograph was taken here, but the structure was not brought out sufficiently to warrant its reproduction. On the north hill-side rock exposures are much more abundant. Near the summit the so-called "foot wall" is exposed. Thence at numerous places down the north side of the hill, large and small ledges are frequently found, some of which are fifteen feet high. Within about 150 feet of the base of the hill at a point, G, nearly east of the company's office, a small vein of the ore has been followed fifty feet or more into the hill-side, giving excellent exposures.

Long vertical exposure above Tunnel 2.

Exposures scarce on the south hill-side.

Exposures near Company's office.

A careful examination shows that there is no essential difference between the rocks at the different exposures on the north side of the hill, below the ore bed, with the exception perhaps of those on the north-east side, just above the lowest tramway which at present passes around the hill to the east. This particular rock strongly resembles devitrified pearlite. It has every appearance of having been a glass which, at present, is wholly devitrified. On weathered surfaces it has a rough appearance as though it had a great many little spheres through it which resisted decay more than the other portions of the rock.¹² The

Differences in exposures.

Devitrified pearlite.

¹² Twelve miles or more to the west, on the west bank of the east fork of Black river, in township 34 N. 2 E., section 16, N. W. quarter, is another rock very like this one.

other rocks on the north side of the hill may be described as compact, reddish brown porphyries which in places are decidedly brecciated, and which have but few porphyritic quartz or feldspar crystals. The fragments in the breccia are essentially of the same material as the matrix, differing only by slight variations in color. The rocks exposed at the two shafts on the south are almost identical with those on the north. This is a very important point, and is contrary to statements often made. The importance of this seemed so great that the fact was verified in different ways. Hand specimens taken from the different places could not be distinguished by those competent to judge and who were familiar with Pilot Knob, nor could any difference be pointed out when the rocks were examined on the ground.

Fragments and cement of breccia are similar.

Hanging wall a ferruginous breccia.

Breccia fragments are porphyry.

Exposures at shafts and Tunnel No. 3.

Exposures at Tunnel No. 2.

The hanging wall of the ore bed is the part so generally called stratified. It is very ferruginous breccia which has always been called a conglomerate. It has iron oxide scattered through it in varying amounts, sometimes to such an extent that an expert is required to distinguish between it and the ore. Even then the distinction cannot always be made, for much that was formerly called "rock," and thrown away, is now being worked over and sent into the market. The fragments in the breccia, or conglomerate, vary from a very small size to more than six inches in diameter. They are universally of porphyry or of felsite. Often they are so bleached by decay that they are easily mistaken for quartz or chert, but a careful microscopic examination shows that they are porphyry. The rocks exposed at the shafts and just above the mouth of Tunnel No. 3 show no indications whatsoever of stratification although they are parts of the hanging wall. Below the air shaft no rock exposures can be found. The surface between Tunnels Nos. 2 and 3 is strewn with boulders from the summit, so that no rocks are exposed until we come to the entrance to No. 2. As we now see it an open cut is here driven to the east through a ledge exposing a wall in some places 30 feet high. About 75 feet to the east from the mouth of this cut is an open space about the same distance across. From the eastern wall surrounding this space one opening leads to the south-east, under the hanging wall, and immediately slopes downwards at an angle of nearly thirty degrees, and ultimately connects with Tunnel

No. 3; another extends upwards to the north-east, to Tunnel No. 1. We have here nearly 300 feet of vertical wall exposed which in some places is 75 feet or more high. Numerous fissures are seen in it, but nothing approaching stratification in appearance. As one faces the east wall of the open space he can trace the ore bed with the so-called "slate"¹⁸ above for about 100 feet.

No true stratification apparent.

Towards the north end of this space, however, the ore bed is found both above and below the slate, with the best grade of ore above. At the south end the ore bed again drops suddenly several feet. It will thus be seen that the ore body is by no means easily followed. An attempt was made in vain to make it conform to a stratum in stratified rocks. If this ore body represent a stratum it should be found in the walls of the cut to the west of the open space. The cut enters this space at the south-west corner, so that the unbroken wall may be followed from the east side around to the wall on the south side of the cut. Large pillars of No. 1 ore are standing in the wall at the east side of the opening, but thence, westward, the ore gradually changes into the ferriferous porphyry wall, or to use a local expression as applied to the conditions represented here it gradually "leans out." If the ore bed at the east side of the opening is a stratum this wall rock is a part of the same stratum. In the same way the ore passes into porphyry in other portions of the mine.

Ore bed not a stratum.

Ore grades into porphyry.

Fig. 2 is an exact copy of the location and extent of the ore bed as shown on the working map kept by the company and kindly loaned me by the superintendent, Mr Crain. It shows that the ore does not reach the west side of the hill below Tunnel No. 1, but gradually "leans out" to the south-west and south. Some distance above the Simpson shaft it becomes very narrow, or stands on edge, as Mr. Crain expressed it. Below this it widens a little for a short distance, and then becomes obliterated. It must be understood that the ore bed does not become thinner until it disappears, as coal seams do at times, but that it gradually changes into porphyry as has already been described when speaking of Tunnel No. 2.

This is illustrated by fig. 2.

¹⁸ This slate resembles a decomposition product of the porphyry, carried to its present position by infiltrating waters. It is by no means a bed of shale.

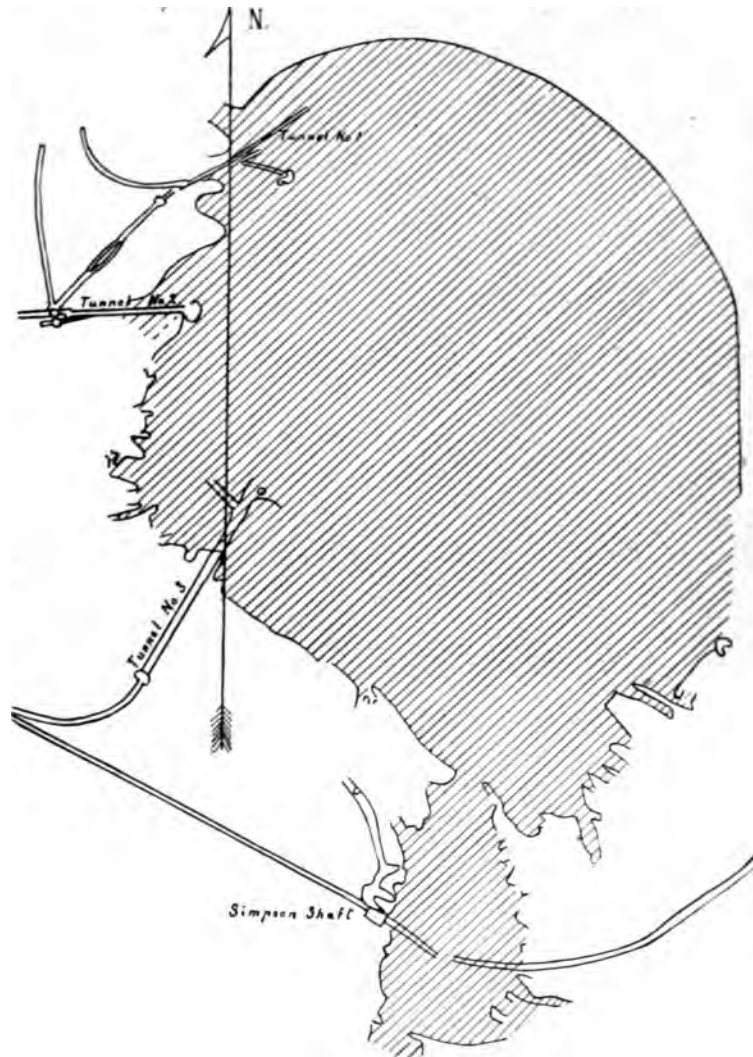


FIG. 2. A sketch map showing the outlines and the extent of the ore bed on Pilot Knob. This ore bed reaches the surface on the north and north-east sides of the hill; but on the west, south-west and south it gradually changes into porphyry. The double line represents the tramways.

It is a remarkable fact that, in the great exposure of vertical wall at Tunnel No. 2, the horizontal fissures are very few compared with those nearly vertical. The suggestion has been offered that the vertical fissures did represent bedding seams and that the strata were inclined at very high angles. But this is contrary to any view heretofore advocated and is contrary to the idea that the ore bed is in the plane of stratification and that it represents a stratum itself; further, if this were true, there would be strata dipping to the south from 70° to 80°, and others within a few feet dipping to the north at about the same angle.

Vertical fissures
cannot represent
bedding planes.

Passing north to Tunnel No. 1, the wall rocks are massive in appearance with many more fissures approaching the vertical than any other direction and often extending from top to bottom of the wall. Farther east we find that the same conditions obtain. The vertical wall is here fully 100 feet high. When the pillars were drawn immense masses of the hanging wall fell and broke into blocks some of which must weigh hundreds of tons. The vertical fissures determined largely the outlines of the blocks. We find the latter generally long and slender vertically, some of them similar to the porphyry needles shown in Plate I. Fig. 1 of Plate II shows the result of this fissuring at and near the summit as well as the massive nature of the rock with its fissures.

Rock massive at
Tunnel 1.

Passing farther to the east we find the appearance wholly changed. Here there is strong indication of stratification, the dip being to the south-east at an angle about the same as the slope of the hill. Fig. 2 of Plate II shows the general appearance on the north-east side of the hill. Thence southeastwards, so far as the works are opened, the same condition exists, and were one's study confined only to the north-east side of the hill, he would certainly think the rocks truly stratified. But why does the same structure not extend through to the west side? One can scarcely conceive of metamorphic action being sufficiently great to entirely obliterate all indications of bedding in the whole base of Pilot Knob to within 150 feet of the summit, and in the western half of the summit also, without affecting strongly the bedding lines in the east half of the summit as well. But this

Pseudo-bedding
on Pilot Knob.

Cannot be true
bedding.

is what we are called on to believe if we accept the theory of the clastic or fragmental origin of the rocks of Pilot Knob.

Fault here im-
probable.

In relation to the supposed existence of a fault referred to on p. 18, if such exist, then it must certainly extend both east and west of the Knob. But no one has ever been able to find it, although careful search has been made.¹⁴ Further, the north wall of the fault, in this case, must also contain the ore bed. Careful search with the diamond drill shows that the ore bed does not exist to the north within a depth of 500 feet below the surface of the porphyry which underlies the limestone in the valley. This surface level is at least 700 feet below the ore bed in the Knob, the limestone covering being 200 feet or more. Therefore, if a fault exist, it represents a vertical displacement of not less than 1,200 feet. We are consequently called upon to believe that a fault exists here, certainly not over one mile in horizontal extent, which caused a vertical displacement of fully 1,200 feet; a most unparalleled condition.

Apparent stratifi-
cation near
Manganese
mines.

Evidences of stratification exist, however, at other places than Pilot Knob, which deserve consideration here. Thus, in section 19, township 33 N. 4 E., at and near the old manganese mines there is some approach to an appearance of stratification. Mr. W. W. Heywoods' house stands on a little hill east of the road, near the center of the section. In digging his cellar he came upon a bluish grey rock in smooth thin layers which seemed to be perfectly stratified. A careful examination of this leads to the conclusion that it is a volcanic tuff, and, as such, would properly be stratified.

This probably the
result of
weathering.

In the immediate vicinity of the manganese mines the surface rocks in places seem to be in nearly horizontal layers. In every instance where a shaft has been sunk these surface strata gradually merge into massive rock of the same nature, with well marked vertical fissures, some of which are sufficiently plain to be followed in sinking the shaft. The same conditions have been exposed by the trenches cut in the hill-sides here. The most reasonable explanation is that the layers are produced by weather-

¹⁴ The statement that the south part of Cedar hill is of the same formation as Pilot Knob rests wholly on lithological similarity. There is no stratigraphic evidence whatsoever in support of it.



FIG. 1. View of the summit of Pilot Knob showing the massive nature of the porphyry rock, the vertical fissures and the angular blocks produced by the falling of the hanging wall.



FIG. 2. View on the north-east side of Pilot Knob, just above the ore bed, showing the pseudo-bedding in porphyry.

1

ing. Good illustrations of such a process of weathering are to be seen just across this same hill to the north in a ravine. Boulders which are lying entirely loose in this ravine are parting into layers on the decayed surface, while within they are perfectly massive.

In general, then, it may be said that only two or three places are known in the whole area studied at which the rock structure at all approaches bedding, and at each of these the conditions can readily be explained in other ways. Not a single instance is known in which any geologist has ever been able to trace a stratum from one side of a hill through to the other, much less from one hill across the valley to its neighbor. Neither can we find differences in the composition of the rock mass so distributed and of such a character as to indicate the difference accompanying stratification. Hills 600 feet high are the same from top to bottom. Hills ten, twenty, thirty, or forty miles apart are the same practically, varying only in the degree of crystallization.

Evidences of
stratification
inconclusive.

2. FLOW STRUCTURE, BANDED STRUCTURE, AND LITHOPHYSE.

The term "flow structure" is used to designate that peculiar wavy, often knotty appearance, so common in slags from the blast furnace and in modern volcanic rocks. It is caused by the flowing movements of the liquid slag or lava. The slight inequalities in the composition of the liquid, or the presence of grains of iron oxide, crystallites, or any other solid particles makes these flow structure lines all the more prominent. The banded structure is produced by the arrangement in approximately parallel bands of materials differing in color and usually in composition. This structure differs from the flow structure principally in having the lines almost free from undulations. Sometimes the layers are very thin and close together. Given a mass of liquid lava with the bands already formed, one can readily see that the farther the lava flows the thinner and closer together the bands will be; for none of them will be destroyed although the lava sheet ever becomes thinner as it spreads over a greater surface. No one character of obsidian and rhyolite is more marked in many places than is their banded

Cause of flow
structure.

Of banded structure.



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Cause of flow
structure.

Of banded structure.

Banded and flow
structure indi-
cate igneous
origin.

structure. Often the different colors are so arranged that they give a beauty and picturesque appearance not observed in any other kinds of rocks. It is reasonable to suppose ancient lavas were banded in an analogous manner. Devitrification and partial decay destroy these lines to a considerable extent, but in many of them they are still apparent. Wadsworth¹⁵ while studying the felsites and porphyries around Boston was perhaps the first to call attention to this point. The banded structure of those rocks he claimed was strong evidence in favor of their eruptive origin.

Examples of such
structure
abundant.

A careful macroscopic examination of the various felsites and porphyries in the area under discussion reveals the fact that in almost every quarter section covered by crystalline rocks numerous good examples of the flow structure and banded structure exist. The most of these are so plain that they can easily be seen, while others require a practiced eye. The weathering very generally makes the markings more prominent. Sometimes they are on so small a scale that a linear inch would include two or more curves; in other places the curves are much broader so that a six inch length could be chosen which would be almost straight. In many of the breccias (called conglomerates by Pumpelly and others) these flow structure lines pass around the imbedded fragments, showing plainly that the fragments were present before movement of the magma had ceased. Figs.

Figs. of Plate III. 1 and 2 of Plate III illustrate this flow structure. Fig. 1 is taken from a rock lying on the surface on the southern hillside at the old manganese mines, in section 19, township 33 N. 4 E., near Mr. W. W. Heywood's and four miles south of Iron-ton. It shows, on a somewhat large scale, the wavy lines passing around the included fragment near the center. Fig. 2 is from a fragment broken from a large exposure of porphyry, or breccia, near the south-eastern foot of Cedar Hill, about 150 yards due north of the little church which stands in the north-western part of the village of Pilot Knob.

The banded structure in some places is more prominent than the wavy flow structure, although as above stated they are genet-

¹⁵ J. S. Diller in Bul. Mus. Comp. Zool. Cambridge. Geol. Series, Vol. I, p. 169.



FIG. 1. View of a porphyry breccia boulder showing flow structure.
From the south hill-side at the Manganese Mines. In N. W. quarter, section 19, township 33 N. 4 E.



FIG. 2. View of a small portion of a brecciated porphyry outcrop showing flow structure.
Original size 8 by 12 inches.
From the south-east side of Cedar hill, opposite Pilot Knob.



ically the same. In other places the banded structure is by no means prominent. Shepherd Mt., almost from base to summit, is a mass of banded felsite and orthoclase porphyry. In the western half of township 33 N. 3 E., the banded structure is especially prominent. Pilot Knob itself in places shows the flow structure very well. The large boulders lying at the north-east corner of the company's office building show them, as does also, and especially plainly, the large rock exposure just above the lowest tramway on the north-eastern side of the summit.

Banded and flow structure on Shepherd Mt. and Pilot Knob.

Sometimes these different layers are an inch or more apart, but usually they are much closer. In a specimen gathered by Mr. G. E. Ladd from the S. E. quarter of section 8, township 33 N. 5 E., in Madison county, no less than thirty of these bands may be counted to the inch. This same specimen has many porphyritic feldspar crystals in it, and a few fragments which give it a brecciated appearance. In every case the bands curve around the feldspar and the fragments, showing plainly that they were present previous to the formation of the bands. These inclusions have further no indication of being water-worn and thus present no evidence in this particular that they were deposited as sediments. The bands themselves, some of which are less than 1-30 of an inch in thickness, could hardly have been formed from sediments; or at least, if formed, they would have been destroyed by any metamorphic action sufficiently strong to reduce the rock to its present condition.

A unique specimen.

In a few cases, in township 33 N. 3 E., appearances were noticed quite like the lithophysæ so common in Obsidian Cliff, of the Yellow Stone National Park. They are not so perfectly formed as those described by Iddings,¹⁶ but still a large number were noticed very much resembling Fig. 7, Plate XIV, of his report. These lithophysæ, of course, would be much more abundant near the original surface, and consequently would be principally removed by erosion. The wonder is, not that so few can now be found, but rather that any are left until the present time.

Occurrence of lithophysæ.

¹⁶ Seventh An. Rep. Director U. S. G. S. 265.

3. BRECCIA.

The term breccia is applied by geologists to a rock partially or wholly composed of angular fragments. Such a rock differs essentially from other conglomerate only in having *angular* fragments instead of *rounded* ones. The ground mass of the rock may be of various materials. In a volcanic breccia it originally was lava. Such a rock may be produced by the formation of a crust on a lava and the breaking of this crust into fragments which are subsequently cemented together by fresh lava; or it may be produced by lava cementing together the angular particles of coarse volcanic ash and other fragments ejected from volcanoes. In a volcanic breccia, therefore, the fragments and the cement or ground mass are often composed of essentially the same material.

Origin of volcanic
breccia.

The breccias of Missouri possess this latter characteristic. They occur very abundantly in many places. Almost all the porphyries in the southern half of township 34 N. 4 E., are brecciated to a great degree. Buzzard mountain, Pilot Knob, and nearly all of Cedar hill are entirely composed of breccia.¹⁷ Just north of Biser mountain, at the Bray place, in section 30, township 33 N. 4 E., a shaft thirty feet deep passes through a hard waxy looking breccia very rich in angular fragments. The whole rock has an unusually fresh appearance. Many other places could be mentioned did space permit and one need not be surprised to find a brecciated rock on any quarter section where porphyry exists.

Character of Mis-
souri breccias.

Occurrences of
breccias.

In all cases the ground mass of these breccias is felsitic or porphyritic, with the characteristic flow structure already described and with angular, or, at most, partially sub-angular fragments. What have been called the conglomerates of Pilot Knob present no exception to this. One important peculiarity

Groundmass al-
ways felsitic or
porphyritic.

¹⁷ On the map accompanying Pumpelly's Report, published in 1873, only portions of Pilot Knob, Buzzard mountain and Cedar hill are represented as containing breccia, or "conglomerate." The brecciated condition is recognizable, however, over the whole of each hill; though, over some portions the included fragments are much less prominent than over others.

of the fragments in the breccia throughout the whole area is that they so often show, to a marked degree, the flow-structures within themselves. Not only this, but sometimes a fragment is in turn composed of smaller fragments. Such a case was seen on the south side of a steep hill north of the Fredericktown road, east of Ironton, in section 35, township 34 N. 4 E., and several similar cases were noticed on Pilot Knob.

Flow structure in
breccia frag-
ments.

As bearing upon the question of the origin of the material of these breccias as well as their mode of formation, the angular shapes of the fragments is opposed to the idea that they were deposited in water. And, further, even could we overlook this, the fact that the material of the fragments is itself porphyry, throws upon us the burden of demonstrating the existence and mode of formation of a still older porphyry. On the other hand, if we call these crystalline rocks eruptives every thing becomes plain. Here and there a crust was formed on the viscous lava which was subsequently broken into fragments by additional flows. These fragments became embodied in the lava, which at times was almost identical in character with the material of the fragments, and at other times was different. Or, occasionally, a mass of angular volcanic ejecta has been overrun by liquid lava which has cemented the particles together. It can, further, readily be seen that differences in the temperature of the lavas would also cause differences in the degree to which the fragments were re-fused, which inference corresponds exactly with the observed facts.

Origin of Mo.
breccias.

Eruptive theory
adequate.

This explanation is the same as that which is known to be applicable to modern volcanic breccia—a rock which is very abundant in certain localities and which is very well known. The remarkable glass-breccia recently described by Professor G. H. Williams,¹⁸ from the Sudbury District of Canada, is also very similar to many of the Missouri breccias, the only essential difference being that the Canadian rocks are almost wholly silicified, while the Missouri ones are composed of the original felsitic material.

Glass breccia.

¹⁸ The Silicified Glass-Breccia of Vermillion River, Sudbury District. By George H. Williams. Bul. Geol. Soc. Am. Vol. 2, p. 138.

4. SCORIA AND AMYGDALOIDS.

Scoria and amygd-
dules rare in
Mo. rocks.

Occurrences of
such.

The Missouri rocks have thus far yielded but few specimens of scoria or amygdules. In rocks so long exposed to eroding agencies it is to be expected that the greater portion of the original surface would be removed. The scoriaceous and amygdaloidal portions of lava are near the surface, and consequently are among the first to be carried away by erosion. Remnants seem, however, to be preserved at a few localities. On the western slope of the hill at the old manganese mines, in section 19, township 33 N. 4 E., a great many boulders of various sizes may be found which are full of openings exactly resembling the gas bubble openings in modern lavas. At some of the shafts similar rocks have been exposed near the surface, showing that the boulders mentioned belong near where they are found. Specimens Nos. 15199, and 15200 collected by the writer, exhibit this structure. Some of these specimens are so badly decayed that they can be crushed with the hand; others are more firm. All of them, however, are so far altered that the original microscopic texture of the rock cannot be determined.

The gas bubble cavities vary in size, from very small dimensions to nearly an inch across. Generally they are quite flattened, and drawn out as is so common in pumice. Other localities exhibit approaches to this, but none show it so well.

Careful search has been made for rocks having the amygdaloidal structure. A few have been found which show it quite well. They will be described more fully later in this article.

5. TUFF.

Origin of tuff.

The name tuff is given to stratified rocks composed principally of volcanic ash of various degrees of fineness, and of different kinds of volcanic fragments. Quite often other materials are mixed with the ash so that the true nature of the rock is difficult to determine. If a volcano is intermittent in its action we may have alternate beds of the ash and of lava. As the ash is ejected it will, of course, settle in layers forming regular strata. The

coarser matter will settle comparatively near its origin, while the finer ash will often be carried hundreds of miles and be spread out over vast areas of country. In this way the various grades of tuff are formed. Grades of Tuff.

These tuffaceous rocks yield to erosion much more readily than does the solid, compact lava, and hence Archæan tuffs are quite rare. A few rocks have been found in Missouri which very closely resemble tuff, and have therefore been classed as such. On the south side of Shepherd mountain a rock was found in broad thin layers, often not over an inch and a half thick, which closely resembles a quartz, porphyry-tuff. In section 19, township 33 N. 4 E., in the vicinity of Mr. W. W. Heywood's, a rock is quite common which is distinctly stratified, and has, in general, a fine, even texture with an occasional larger fragment in it. It is of a light bluish grey color, shading off into a reddish brown in places. It has the peculiar property of exploding with considerable force when heated, so much so that it has been called "explosive rock." This is probably a tuff. Scarcity of such among Mo. rocks explained.

Near the same place, on the south and west sides of the hill, at the manganese mines, are rocks which, though different from those described, resemble some varieties of tuffs more than they do any other rock. Some of these are comparatively coarse with odd-shaped fragments inclosed. This type is abundant near Mr. Heywood's spring, west of his barn. Others are very fine grained and have a jaspery or flinty appearance, but under the microscope are seen to be neither glassy nor composed of quartz. They very closely resemble the "dense" or "compact" tuff described by Rosenbusch.¹⁹ In Pampelly's Report for 1873, p. 26, a rock is described as being a mixture of porphyry and limestone, certain streaks in it having more than 31% of lime. A careful but unsuccessful search was made for this rock. As it is said to occur in section 19 of this township it is possibly a banded tuff. The calcite in it may have been of secondary origin. Such changes are quite common in tuffs that are much weathered. Occurrences of tuff described.

¹⁹ Mikroskopische Physiographie der Massigen Gesteine, p. 419.

Compositions of
tuff.

The various kinds of tuffs are easily changed into comparatively compact rocks, having a composition depending on the nature of the eruptives accompanying them. Quartz-porphry tuff somewhat resembles quartz-porphry; diabase tuff resembles diabase, etc. Chemical analysis therefore would show no particular difference between an eruptive rock and the corresponding tuff.

6. ABSENCE OF GRADATION OF CRYSTALLINE INTO NON-CRYSTALLINE ROCKS.

Gradations common in metamorphosed rocks.

If the crystalline rocks of Missouri be metamorphosed sediments, it is more than probable that, somewhere, careful examination would reveal intermediate stages between the crystalline and the non-crystalline forms. In all the classic illustrations of sediments being changed into crystalline rocks there is a central area in which the change was greatest, and from which, in all directions that the rocks extend, a gradual diminution in the metamorphic effects is traceable.

None such found in Mo. rocks.

Nowhere, in the area under discussion, has the writer yet found a rock that seemed to be at all intermediate in texture between the crystalline and the sedimentary rocks. No central area has been found more crystalline than its neighbors — excepting in so far as the granites are different from the porphyries. There is always a sharp line between the porphyries and the overlying sandstones and limestones; some of the latter, it is true, are changed into marble, but there is nothing about such change indicating a transition of the Archæan rocks into these or any other stratified rocks.

Gneisses and schists absent.

Stranger still is the fact that nowhere have any rocks been found at all resembling either gneisses or schists. In other localities, where sediments have been changed to crystalline rocks, gneisses, and schists are more abundant than any other kinds of rocks. If, therefore, the granites and porphyries of Missouri are of clastic origin they are entirely unique in these two particulars.

B. PETROGRAPHIC EVIDENCE OF ERUPTIVE ORIGIN.

1. TEXTURE OF THE GROUND MASS IN THE
PORPHYRIES AND BRECCIAS.

The ground mass in the porphyries, whether brecciated or not, is the same. Whatever descriptions are applicable in the one case hold equally well for the other. There is a great variation in the degree to which crystallization has been carried, and a corresponding difference of texture for each of these several steps. Expressed in petrographic language these various textures should be named as follows: microgranitic, micropegmatitic, granophyric, felsophyric, and vitrophyric.²⁰ The writer has elsewhere suggested the term "poecilitic"²¹ to express a fifth structure, but it need not here be discussed.

These textures of ground mass are characteristically such as are found in apparently similar rocks of unquestioned eruptive origin. An extended comparison has been made between hundreds of thin sections of these rocks and thin sections of other rocks from many parts of the world; from Germany, France,

Textures of porphyries.

Textures of Mo. rocks similar to those of foreign eruptives.

²⁰ The term microgranitic refers to a texture similar to that found in granite, excepting that it is so fine grained that the microscope is necessary to study it. The micropegmatitic structure is the same as that seen in pegmatite or graphic granite, so fine grained that the microscope must be used to see it. The term granophyric means practically the same, and is usually applied when the quartz and feldspar crystals are long and slender, especially if there is a tendency to radiate from a point, forming a pseudospherulite. The term felsophyric structure is about the same as microfelsitic which referred primarily to the structures of the groundmass in a felsite; but as there is no essential difference between a felsite and a porphyry, excepting the accidental absence or presence of porphyritic crystals, a more exact definition should be given. As used to-day it refers to a ground mass which is holocrystalline, but which is so fine grained that the constituent minerals cannot well be determined. It has been suggested that possibly these crystals are in the form of thin plates or discs which overlap each other, but this has not been demonstrated. The vitrophyric structure is found in rocks with either a glassy or a devitrified ground mass. They were originally glassy, but in the process of ages microcrystallization has taken place. Such rocks are quite scarce in Missouri, but occasionally are found.

²¹ A contribution to the Archæan Geology of Missouri, Am. Geol. Vol. I, p. 368.

Mo. porphyries
similar to Bos-
ton felsites.

No sedimentary
rock has a sim-
ilar ground
mass.

Ground mass the
same in brec-
ciated and non-
brecciated
rocks.

Scandinavia, Great Britian, and several different places in America. The last of these comparisons was made with the Boston felsites. Prof. W. O. Crosby kindly sent slides from his collection which illustrate the Boston rocks, about which there was formerly some difference of opinion. At present every one admits that they are eruptives. There is a close resemblance between these sections and the ones from the Missouri rocks. In fact they so closely resemble each other that one is not able to state any essential difference between them. The same may be said of the results of the other comparisons made. The groundmass in porphyries of undoubted eruptive origin is identical with the groundmass of the Missouri rocks. Further, not a single case is known to the writer of any rock from any locality whatsoever which is of undoubted sedimentary origin that has a groundmass at all similar to that of these rocks.

Further, as important in this connection, is the fact that the groundmass in the felsites and porphyries is the same whether they be brecciated or not, and that the material is the same in both cement and fragment of the breccia. The first point can readily be established while in the field, even without the use of the microscope. Literally hundreds of instances have been seen of breccias with a cement or groundmass of genuine quartz porphyry. Under the microscope this groundmass is identical with that in the non-brecciated rocks. In some cases it is quite coarsely crystalline, forming a coarse microgranite; while in others it is decidedly vitrophyric. Further, with reference to the second point, a slight variation in color is often the only distinction between the fragment and the matrix color of the rock. Specimen No. 15,325 of the writer, from the ledge just above the air shaft on the south-west side of Pilot Knob, and No. 15,326, from the Simpson shaft, are good examples of this. The thin section of each contains several small fragments. In natural light the microscope shows that the matrix has partially dissolved the inclusions, so that in some instances the two grade into each other by almost imperceptible changes. The outlines of the fragments can best be seen by holding the slide between one and the light and looking at it with the naked eye, or with a hand lens. The difference in color is then quite marked. But when one uses the

microscope, with both polarizer and analyzer, he can see no difference whatever between the matrix and the inclusions, neither can he at all determine the outlines of the latter. In other cases the division line between these two parts is marked off by a row of grains of black oxide of iron, which makes a sharp distinction. Again the matrix may have the flow structure well developed while such is absent in the inclusion, or the inclusion has the flow structure and the matrix is without it. In all cases, however, the nature of the groundmass is substantially the same in both matrix and inclusion.

Iron oxide grains
outline frag-
ments.

One apparent exception should, however, be made to the above statement. In the Pilot Knob breccias the little grains of ore are always deposited in the cement or matrix and never, so far as yet seen, in the inclusions. This fact makes the apparent difference between the two parts greater than it really is. In the solid ledges at the two shafts very much less ore is deposited and consequently the rock is more nearly of a uniform hue. In other parts of the country, where the ore is absent, this apparent difference is not so noticeable. The ore being deposited in the matrix and not in the fragments is a point which may prove of great value in arriving at reliable conclusions regarding the origin of the iron ores of Pilot Knob.

Grains of iron ore
never in breccia
fragments.

2. FLOW STRUCTURE IN PORPHYRIES AND BRECCIAS.

The general discussion of the flow structure as seen in the field has already been given. It only remains to show how this same flow structure exists even in microscopic form. Many of the felsitic rocks are so compact that they seem to be amorphous when viewed macroscopically. Very often these same rocks under the microscope show the most beautiful evidences of flowage. The little hill in Arcadia on which stands the Methodist church is composed of just such a rock. Macroscopically the rock on the north-east side of the hill looks almost like glass; it has a genuine conchoidal fracture, though weathered surfaces sometimes show the flow structure most beautifully. Under the microscope the rock appears very wavy. Down the hill to the north, just at the south end of the wagon bridge on Stout's creek,

Flow structure
revealed by the
microscope.

is a compact, spotted breccia, the general properties of which are very similar to those of the rock on the hill to the south. The big hill on the south bank at the "Shut-in" east of Ironton is composed of a similar rock. Specimens gathered from the west foot hill are brecciated, the fragments often being of microscopic dimensions. They show the wavy lines passing around the fragments and the porphyritic crystals in a remarkable manner. Fig. 1, Plate IV illustrates these conditions.

Flow structure
exhibited at the
"Shut in."

Many other localities were visited which show the same phenomena equally well as the two given. Fig. 2, Plate IV is from the west bank of the east fork of Black river, in section 16, township 33 N. 2 E. This rock is peculiar in that the weathered surfaces are rough, being covered with little spheroidal protuberances 1-4 to 1-3 of an inch in diameter. In general appearance it is very similar to the vitrophyric rock before mentioned on the north-east side of Pilot Knob. When it is broken the fresh surface appears very compact. It is probably an ancient vitrophyre.

Vitrophyric ap-
pearance.

Both figures of Plate IV. are photomicrographs reproduced, so that their accuracy is indisputable. Many others could be added in illustration of the same phenomenon in specimens collected from other localities.

3. BROKEN CRYSTALS DUE TO FLOWAGE OF THE LAVA AFTER THE CRYSTALS WERE FORMED.

When motion in a viscous magma continues after crystals are formed in it they often become fractured, and at times the fragments of the crystals are entirely separated. Conversely, when a rock, with a porphyritic structure, has bent and broken crystals, it is strong evidence that the rock mass at one time was molten, provided there is no indication that the breaking was subsequent to the solidification of the rock. In mountainous districts and regions subjected to great orographic disturbances rock crystals are often greatly affected. But the distinction is plain between such a rock and one whose crystals were broken by the last movements of a cooling magma. The Missouri rocks bear no indication whatsoever of any serious orographic movements. Not

Phenomena of
flowage.

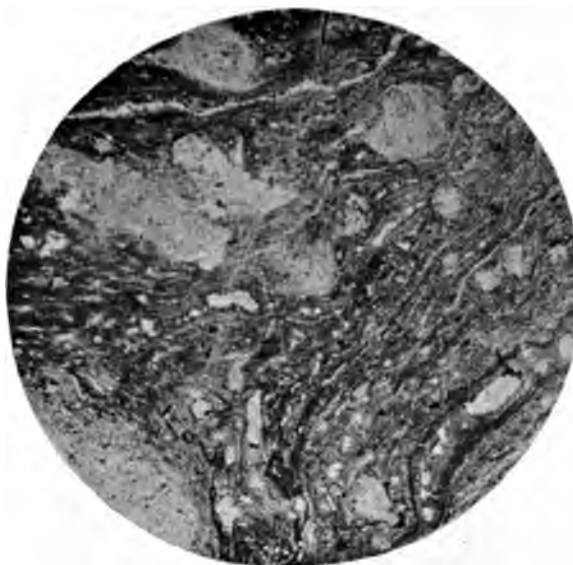


FIG. 1. Photo-micrograph showing flow structure around included fragments and porphyritic crystals. (Haworth Sp. 15,152) x 44.

From base of hill on south side of Stout's creek at the "Shut-in." In S. W. quarter, section 2, township 33 N. 4 E.



FIG. 2. Photo-micrograph of quartz porphyry with flow structure well developed. (Haworth Sp. 15,371.)

From N. W. quarter, section 16, township 33 N. 2 E., on East Fork of Black river.



a single instance has been seen of even one of the commonly accompanying results of such movements. No evidence of orographic movement seen

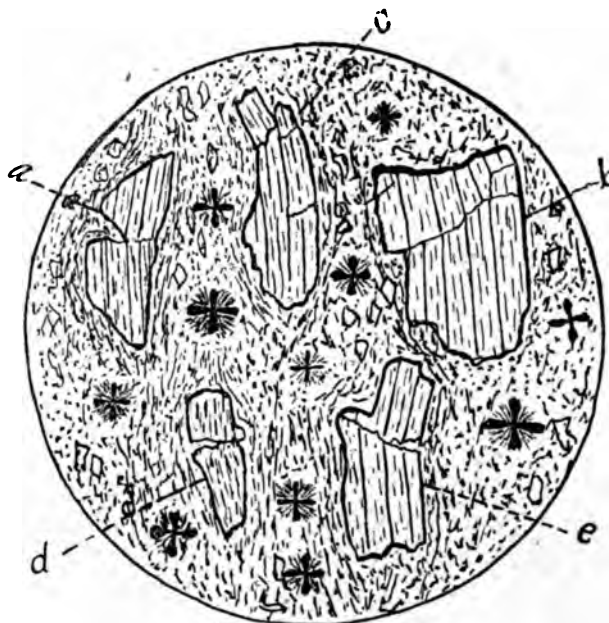


FIG. 3. Sketch showing the microscopic appearance of bent and broken crystals. The groundmass is spherulitic and shows the flow structure. (Taken from Haworth *Sps.* 15,403 and 16,404) x 44.

Bent and broken crystals, however, exist. Several different coarse grained feldspar porphyries have feldspar crystals quite badly fractured. Fig. 3 shows some of these. They were chosen from thin sections made from two different specimens. Nos. 15403 and 15404, from the north-east and north-west quarter respectively of section 2, township 33 N. 3 E. The two specimens are in every respect almost identical, light gray in color, with so many porphyritic feldspar crystals that the rock looks almost like granite porphyry. A microscopic examination shows that the groundmass is very fine grained, in some places has the flow structure decidedly marked, and has numerous spherulites here and there through it. The broken crystals generally have their

Bent and broken crystals frequent.

Corroded crystals seen. corners corroded, and frequently a re-solution has taken place along the lines of fracture; a, d, and e, in the figure show this quite plainly.

Crystal fragments separated. Some cases were seen, in the same thin sections, in which fragments of the crystals are entirely removed, the fine grained magma separating them by some distance. The relations between the two portions of the crystals are such that no doubt can exist about their once having belonged together. These relations consisted in similarity of general outline, in correspondence in nature and number of the twin laminae, and, sometimes, in an agreement between the irregularities of the broken surfaces. This latter is not very common, however, because the magma so often corroded the fresh surfaces formed by the break.

4. MAGMATIC CORROSION OF PORPHYRITIC CRYSTALS AND INCLUDED FRAGMENTS.

Corrosion of crystals explained. In our modern volcanoes, as is well known, crystals of pyroxene, leucite, nepheline, hauyne, etc., often are formed before the lava is ejected. It frequently happens that, by the eruption the nature of the lava is slightly changed so that the same molten mass in which the crystals were formed now becomes a solvent for them. At that moment their solution begins, but it is soon arrested by the solidification of the lava. Thin sections made at random through such rocks show the irregular outlines of the porphyritic crystals produced in this way.

Crystals and fragments corroded in Mo. porphyries. Nearly all of our modern volcanic rocks, and the ancient eruptive porphyries have their porphyritic crystals corroded in a similar manner and by a similar cause. The Missouri porphyries show, in a marked degree, the same characteristics. Every-where, east, west, north, and south the same phenomena are abundant. In all cases the groundmass fits around the corroded crystal in such a way as to leave no possibility for supposing that the crystals were water-worn before they became constituents of the rock in which they are now found. The included fragments in the breccias also have, in a majority of cases, suffered a similar corrosion, especially if the fragments are small. Some of the larger fragments, and occasionally the smaller ones, do not show

this, but if they are formed in the manner indicated we should expect to find such difference; in some cases the magma would solidify in a much shorter time after coming in contact with the fragments than at other times.

The following illustrations exhibit what is here referred to. It need only be said that no process is known to geologists by which such results can be produced excepting by the corrosive action of a molten magma. Conditions illustrated can only result from action of a molten magma.

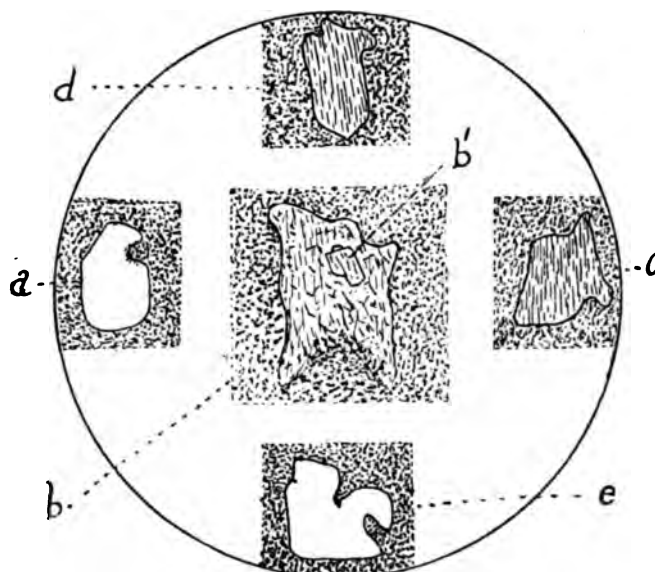


FIG. 4. Sketch showing the microscopic appearance of quartz and feldspar crystals, and of an included fragment in a breccia which have been subjected to magmatic corrosion. X 44.

- a. Corroded quartz crystal from quartz porphyry. Township 33 N. 3 E., section 19, S. E. quarter. No. 15428.
- b. A corroded included fragment containing a corroded feldspar crystal, b¹. From a black, fine grained felsite or porphyry by roadside. Township 34 N. 4 E., section 9, N. E. quarter. No. 15369.
- c. Corroded orthoclase crystal from quartz porphyry. Township 34 N. 4 E., section 22, N. W. quarter. No. 15354.
- d. Corroded orthoclase crystal from a breccia at railway cut on Graniteville branch, in west part of Middlebrook. Township 34 N. 3 E., section 12, S. E. quarter. No. 15291.
- e. Corroded quartz crystal from quartz-porphyry. Township 33 N. 4 E., section 2, S. W. quarter. No. 15180.

5. AMYGDALOIDS.

Occurrences on
Russell Mt.

Russell mountain, across the valley to the south-west of Shepard mountain, is one of the highest and largest hills in Iron county. Nearly all of the northern and north-eastern part of this hill is covered by a porphyritic rock which is slightly different in general appearance from any others thus far noticed in the district. In some places it closely resembles the lighter colored dike rocks found in places in this country; at the northern extremity of the hill, where the Black River road crosses, east of the Reagan place, it was at first mistaken for such a dike rock. On the east side of the northern spur of the hill, about one-third the distance from the base to the summit, is a broad smooth ledge which has also the appearance of an overflow of the dike material. This place can easily be found on the south side of the old road which leads up the hill to the diggings which were formerly operated on Russell mountain. An attempt, however, to locate and define these supposed dikes, showed that the whole north-eastern part of the hill, and at least a part of the western slope was covered with rocks which were of the same general character and, in addition, seemed to be somewhat open and porous in places. Numerous large boulders are scattered here and there on the hill-sides as on other porphyry hills. Many of these boulders are filled with little cavities, usually lined with a green looking coating resembling the decay products of iron bearing rocks. Fresh surfaces show that the rock has, further, numerous lath-shaped feldspar crystals scattered through it. Whether or not this rock gradually merges into the ordinary porphyry on the south was not determined to a certainty; although considerable time was spent in the attempt. It is probable that this is the case, for no indication of a contact line between the two kinds of rock was found, and it is known that some of the little foothills on the east consist of rock similar to that which covers the north-eastern portion of Russell mountain.

Boulders filled
with cavities.

The rock is mi-
croscopically an
amygdaloid.

A microscopic examination of this rock indicates that it is a true amygdaloid. The cavities are roundish in form, some are filled with quartz which breaks into numerous individuals when

examined with crossed nicols, and some have chloritic material which is probably leached from the adjacent parts of the rock. ^{Chlorite crystals in cavities.}

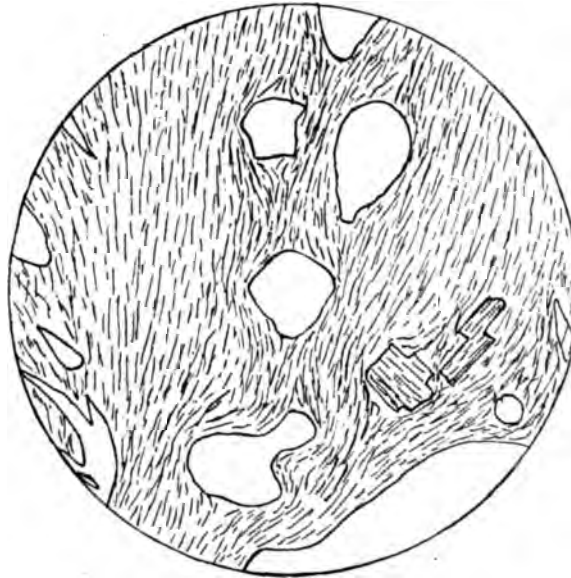


FIG. 5. Sketch from a thin section of an amygdaloid. The groundmass shows the flow structure plainly. It is filled with minute lath shaped feldspar crystals not shown in the figure. The cavities are now filled with quartz which is evidently secondary. At numerous points throughout the rock there are macroscopic porphyritic feldspar crystals, two of which are shown in the figure.

(Haworth Sp. 15, 407.)

From the north-eastern portion of Russell Mt., in the S. E. quarter, section 3, township 33 N. 3 E.

The groundmass of the rock seems to have been originally a veritable glass filled with numerous minute lath-shaped feldspar crystals; it shows the flow structure as strongly as any rock the writer has ever examined, not excepting even the modern eruptives. In this flow structure there is most suggestive evidence that these cavities were formed before the solidification of the magma, for the flowage lines curve past the rounded outlines of the cavities in such a way that it does not seem possible one could be mistaken in diagnosing them. An attempt was made to photograph one of these, but the rock section was a little too thick, and the dark parts of the ground mass overpowered the ^{Flow structure strongly developed.}

Fig. 5.

lighter parts to such an extent that the representation was imperfect. Fig. 5 is offered as a substitute and, while it does not exhibit all that one might wish, the apparent flowage structure is by no means exaggerated.

6. ABSENCE OF METAMORPHIC MINERALS.

Common meta-
morphic min-
erals.

Such are constant
accompaniments
of metamor-
phism.

None found in Mo.
crystalline rocks.

Metamorphism, whether produced by great orographic movements which develop heat and pressure, or by the contact of large volumes of molten matter with sedimentary rocks, always develops a certain class of minerals known as metamorphic minerals. The most common of these are garnet, staurolite, epidote, andalusite, cyanite, fibrolite or sillimanite, wollastonite, long, slender crystals of tremolite and actinolite, and certain varieties of brown and white mica and of pyroxene. This last does not include the minerals produced by volatile products of fumerole action, such as fluorite, topaz, tourmaline, wolframite, cassiterite, zinwaldite, etc. Not a single case is known of a metamorphosed area having been carefully studied which did not produce, not only one of these minerals, but a large proportion of them. Well authenticated cases are known of crystalline rocks being produced from sedimentary rocks belonging to almost every geological age from the Silurian to the Cretaceous. But in all these cases quite a number of the above list of minerals are comparatively common. We all know how the New England rocks are filled with garnets and staurolites; how the crystalline limestones and marbles are filled with brown mica, wollastonite and some of the pyroxenes; how the contact zones bordering on eruptives abound in andalusites and fibrolites. It is reasonable to suppose, therefore, that, if the Missouri crystalline rocks are metamorphosed sediments, at least some of these characteristic metamorphic minerals would be present. All that can be said is that they have not been found, though earnestly sought for in the field. Over six hundred thin sections of rocks from all parts of the district have been examined and none of these minerals have been found, excepting such as were evidently produced by weathering, viz.: white mica, epidote, etc. Not a single crystal of garnet, of staurolite, of andalusite, of cyanite, or of sillimanite has been found anywhere in this part of the State.

**NOTES ON THE CLAYS AND BUILDING
STONES OF CERTAIN WESTERN CEN-
TRAL COUNTIES TRIBUTARY TO KAN-
SAS CITY.**

By G. E. LADD, assistant geologist.

(43)

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PREFATORY REMARKS.

These notes on the clays and structural materials of certain western-central counties are, in one sense, complementary to the report on the clay and stone industries of St. Louis, published in Bulletin No. 3, inasmuch as the two articles together describe the industries of, and the raw products most available to the two distinctively large cities of the State.

A summary of the statistics of production contained in the tables of this article gives the following figures for the amounts of the various products during the year 1890:

Structural brick	88,380,000
Gallons of pottery.....	955,000
Tons of clay manufactured into sewer-pipe.....	65,000
Feet of drain tile	65,000
Feet of chimney flues.....	3,000
Stone quarried.	
Lin. ft. of curbing.....	58,639
Perch of rubble and footing.....	109,315
Yards of rip-rap and macadam.....	28,519
Feet of range or cut stone.....	13,350
And about 50 car loads of curbing and 25,000 square feet of flagging, curbing and building stone.	

Had Kansas City, during the past year, been in a condition of normal activity, the amount of these products would undoubtedly be much greater; but the depression in business affairs which has prevailed in this city has necessarily had its influence upon the industries here treated of. With the renewal of vigorous life, which must undoubtedly come to a place so advantageously located as is Kansas City, in the midst of a country rich in natural resources, these industries will undoubtedly assume much greater proportions within a few years.

The stage of progress of the work of the Survey, on the clays and structural materials of the State, renders it probable that no other bulletin article on these subjects will appear. It is at present the plan to push the field and laboratory work incidental to these investigations as rapidly as possible and our next publication embracing such matter will probably be of the nature of a final report upon these materials for the

whole State. The results of the large amount of analytical and experimental work which has been in progress upon the clays will be embodied in such a report, together with full descriptions of all important occurrences and information upon the value and adaptabilities of the different clays. We can unreservedly predict that this volume will be an invaluable one to all interested in the clay deposits and the clay industries of the State.

For assistance in prosecuting this work in these western counties, the Survey is under especial obligations to Dr. J. H. Britts, of Clinton, who has always unhesitatingly given his time and attention to assisting in promoting the work of the Survey when in his neighborhood, to Mr. E. T. Keim, to Mr. E. Butts and to Mr. Edwin Walters, of Kansas City, who have generously contributed information and tendered their support to the work of the Survey on many occasions.

ARTHUR WINSLOW,
State geologist.

NOTES ON THE CLAYS AND BUILDING STONES OF CERTAIN WESTERN CENTRAL COUNTIES TRIBUTARY TO KANSAS CITY.

INCLUDING BATES, CASS, HENRY, JACKSON, JOHNSON, LAFAYETTE AND VERNON COUNTIES.

BY G. E. LADD, ASSISTANT GEOLOGIST.

The following brief notes are offered as a descriptive outline of the clay and stone resources of the area discussed, and of their dependent industries. A more specific report in the future, will include the results of the analyses and tests of those occurrences of clay and stone which seem worthy of complete examination. The writer is indebted to Mr. Elston Lonsdale and to Mr. Leo Gluck for aid in the field, and to Mr. E. Butts, City Engineer of Kansas City, for a valuable statistical table of the stone quarries of that place.

GENERAL GEOLOGY.

In the area under consideration the geological formations occurring represent the Quaternary, Coal Measure and Lower Carboniferous periods.

QUATERNARY.

The Quaternary deposits are represented by Loess, alluvium drift, soils and residuary clays. The drift is but slightly developed. The other forms occur abundantly.

COAL MEASURES.

The Coal Measures occupy nearly the entire area. They have a general westerly dip, and expose in succession, according to

Fire clays and sandstone in lower beds.

the determinations of the earlier geological surveys of the State, beds of the Lower, Middle and Upper Coal Measures. They consist essentially of alternations of limestones, sandstones, shales, clays and coal. The limestones are found mostly in the upper part of the Coal Measures, and are rarer among the lower beds; here, however, coal deposits, argillaceous shales, sandstones and fire clays are most highly developed. The beds in places are somewhat flexed, and probably, in a few localities, are faulted.

LOWER CARBONIFEROUS.

In the south-eastern border of our area the Lower Carboniferous rocks reach the surface, and are represented by the limestones of the Keokuk and Burlington formations.

THE CLAYS.

The geological sources of clay are confined to the Quaternary and deposits and to the Coal Measures. Each of these is briefly discussed in the following notes, and will be again considered in the notes by counties.

Quaternary and Coal Measures the sources of clays.

QUATERNARY CLAYS.

The Quaternary clays which are available for manufacturing purposes, consist of alluvium, Loess and residuary clays.

Alluvium: — Heavy deposits of alluvium occur along many of the streams. They form an uncertain quality of clay for the manufacture of common bricks, but are used for that purpose at several localities.

Alluvium for common brick.

Loess: — The Loess occurs in thick and extensive deposits. It is confined chiefly to the neighborhood of streams, and is most highly developed along the Missouri river. Its chief use is for the manufacture of building bricks.

Loess for building brick.

Residuary clays: — These result from the decomposition of limestones and shales. The breaking down of beds of shale has gone on extensively, and frequently the product is a plastic potter's clay of good quality.

Residuary potter's clay.

Soils: — The soils considered as clays for manufacturing pur-

poses are comparatively of little value; they are usually the last resort of the brick maker. They are, however, available in all localities and when other materials are wanting they are frequently made into a good quality of building brick. They are variable in character, and can only be worked to the depth of one or two feet from the surface.

Soils for building brick.

COAL MEASURE CLAYS.

These consist of impure fire clays, many varieties of argillaceous shale, potters clays and paint clays. They furnish the clay material to a large number of industries. The greatest variety of valuable clays and shales occurs among the beds of the Lower Coal Measures, and are therefore confined, mostly, to the eastern and southern members of this group of counties.

Coal Measure clays of many varieties.

Fire clays:— These occur frequently in the Lower and Middle Coal Measures. They often underlie beds of workable coal, and could be mined in connection with the coal. In places they lie close to the surface with little or no stripping above them. They are not generally sufficiently pure for use in high grades of refractory material, but they will make fire brick of a fair quality. They are, mostly, highly siliceous, and are stained with iron oxide. They are mined in a number of places, and shipped away, or consumed locally in the manufacture of pottery, sewer pipes and paving bricks.

Fire clays suitable for fire brick.

Clay shales:— A great many beds of clay shale occur, varying in thickness from a few inches to forty feet or more. They vary widely in character not infrequently grading into sandstone. They are often bituminous or calcareous and most of them contain numerous concretions or thin seams of iron ores. They vary in color from black, green and red to a light gray. Some are soft, but usually they are hard and tough except after exposure to the action of the weather. The clay shales of the Upper Coal Measures are more apt to contain impurities, especially in the form of calcareous matter, which, when occurring abundantly, renders them worthless for manufacturing purposes.

Clay shales are of varying composition.

Potter's clays:— Clays suitable for the manufacture of pottery occur in a number of places, but they are practically limited to the Lower Coal Measures. They vary greatly in color and

Potter's clays limited to lower Coal Measures.

in degree of plasticity. They are usually interbedded with thin seams of iron ore, or carry a great many concretionary masses of either hematite or limonite. These impurities are more or less easily eliminated in the process of excavating the clay from its bed. The clays are mined, wholly, either in open cuts, or strip pits.

Impurities in pot-
ter's clays.

Paint clays: — Masses of ochre and iron stained clays of deep red and pink colors occur in a number of places among the beds of the Lower Coal Measures. They are often suitable for the manufacture of paint, and are also easily accessible.

BUILDING STONES.

GENERAL REMARKS.

Two sources of supply of building stone material may be recognized geologically within the area described, namely, the Coal Measures and the Lower Carboniferous. The outcrops of the limestones of the latter formation are limited in number, and are at present comparatively inaccessible. They are capable, however, of furnishing an abundance of good building material. The Coal Measures supply both limestones and sandstones.

Building stones
from Coal Meas-
ures and Lower
Carb. rock.

LIMESTONES.

In addition to the isolated limestones of the Lower Carboniferous outcrops, there are a number of beds in the Coal Measures capable of supplying limestone for a variety of purposes. These beds vary much in thickness and in the quality of stone. The workable beds are practically confined to the Upper Coal Measures, and geographically, to the central and north-western part of our area. The material which they furnish is in places adapted for the production of dimension stone, but more generally for macadam, flagging, foundations and lime making. Some beds yield, in large blocks, stone which can be handsomely and easily dressed. One bed furnishes a marble which takes an excellent polish, has a dark bluish drab color, and is handsomely variegated with the outlines of many fossils.

Coal Measures
furnish lime-
stones.

SANDSTONES.

The sandstones of this area are confined, probably, to the Lower and Middle Coal Measures. They vary in thickness from a few inches to ninety feet or more. They are usually micaceous, and not infrequently highly calcareous. In many places they are intermixed with bituminous matter. They occur, sometimes, apparently massive, again in thin slabs suitable for sidewalk flagging, and oftentimes crossbedded, or with the successive beds varying very much in character. Many of the beds furnish a good quality of dimension stone, which is durable, strong and easily dressed. Some are suitable for the manufacture of good grindstones.

Coal Measure sandstones of variable character.

As the sandstones usually vary rapidly in character in the same bed, conclusions as to the value of the stone as a whole for quarrying, from observations at any one place, are unreliable. A bed which appears locally to be of suitable thickness and character is likely in a very short distance to occur separated into several beds, or to have such flaws in it as to necessitate a great waste in the selection of material. The flaws occur, in different localities, as joint planes, concretionary masses of iron ore, discolorations, crystals of iron pyrites, loose uncemented masses of sand, bitumen and seams of coal.

Characteristics of a bed are local.

DESCRIPTIVE NOTES BY COUNTIES.

BATES COUNTY.

With the exception of a few Quaternary deposits the exposed beds in Bates county belong entirely to the Coal Measures, the Lower, Middle and Upper divisions being represented.¹

Only coal Measure beds occur in Bates Co.

The southern half of the county is occupied, almost wholly, by the Lower Coal Measures.

¹ They have been described at some length by Professor G. C. Broadhead, in a report on Bates county published in the Report of the Missouri Geological Survey, 1873-74.

THE CLAYS AND THE CLAY INDUSTRIES.

Soils, alluvium and Loess worked. *Quaternary Clays:*—The workable Quaternary clays of Bates county consist of the soils and alluvial deposits, which are at present used for brick making, and of Loess which occurs along some of the streams. The latter is worked in the bluffs of a creek about one mile east of Butler where it furnishes material for the manufacture of brick and drain tile, at Butler.

Loess 25 ft. thick. The Loess is about twenty-five feet thick at the point on the creek where it is worked.

Fire clays under coal beds. *Coal Measure Clays:*—Fire clays are usually found underlying the coal beds. They may be seen at any of the coal strip-pings, but the whole thickness of a bed is rarely exposed. Several of these fire clays were bored into with a hand augur, and found to contain a large amount of impurity in the form of iron oxide.

Argillaceous shale abundant. Argillaceous shales occur in the Coal Measures here in great quantities. The best of these, seen, were in the neighborhood of Foster. About a third of a mile south of the school house, at this place, at a coal stripping, about fifteen feet of argillaceous shales are exposed. It constitutes the stripping of the mines, and is immediately underlain by the coal. It varies in color, is very tough, fissile and gritless. So far as can be judged by a macroscopic examination this shale seems well adapted to the manufacture of sewer pipes and paving bricks. A poorer quality of shale is exposed at the mines about Rich Hill.

Suitable for sewer pipes.

THE BRICK MANUFACTURERS.

Product and plant. *Anderson, David:*—Mr. Anderson has a brick yard at Rich Hill. It was started in 1880. Common, hand-made bricks, only, are produced. They are made of soil which is suitable to a depth of about two and a half feet. Five clamp kilns have been erected, but only two of them are at present in use. In 1889 about nine hundred thousand bricks were made, and in 1890 about six hundred thousand. The average price which they brought was five and a half dollars per thousand.

Power & Brothers:—This firm has a brick yard at Butler, which was started in 1881. The clay used is Loess. It is taken from the creek bluff east of town, mentioned above. The plant ^{Product and plant.} consists of two clamp kilns, one hand press, one steam mixer, and one small engine. The product in 1889 consisted of six hundred and fifty thousand bricks, which brought an average price of seven dollars per thousand.

THE DRAIN TILE WORKS.

Miller & Son:—This firm manufactures drain tile, fire clay chimney flues, and fire brick at Butler. Formerly, some pottery was produced. The industry was started in 1878. The clay for tile comes from the Loess deposit mentioned above. The fire clay comes from Vernon county. The plant consists of one circular, up draft kiln, one tile machine, drying rooms, etc. The product in 1889 amounted to about fifty thousand feet of drain tile, and about three thousand feet of fire clay chimney flues.

THE BUILDING STONES AND THE STONE INDUSTRY.

The Coal Measures furnish an abundance of building material suitable for the local demands. The best quality is found among the sandstones. A stone supposed to be the equivalent of the ^{Coal Measure sandstones.} Warrensburg sandstone occurs in a number of localities, where it may be quarried to advantage.

Limestones are quarried, locally, in a small way, for building purposes. The sandstones are quarried for building and dimension stones, and, at one locality, about a mile east of Butler, a white sandstone is quarried by the firm of Miller & Son, in a small way, to be used in the production of fire brick.

Day, T. J.:—Mr. Day has a quarry in sandstone, on the bluff of a creek about three and one-half miles south of Butler. The section at this quarry is as follows:—

	FEET.	INCHES.	
1. Soil and decomposing sand-stone.....	6		
2. Sandstone, cross-bedded, containing numerous streaks of bituminous matter. (These seem to be the remains of some bed of coal destroyed at no great distance, and re-deposited here with the sand).....	6		Section south of Butler.

FEET. INCHES

3. Sandstone, a solid, unbroken bed, varying, from the top downwards, from a light grey to a dark bluish color. It sometimes contains little cavities, partially filled with a reddish substance, which probably contains organic remains..... 13

Stone soft, but
does not "wash."

Stone is quarried by handpicks. It is very soft and friable when quarried, and can be crumbled between the fingers, but it soon hardens on exposure to the air. It dresses easily, and will admit of considerable carving. It is claimed that it does not "wash," and that it resists weathering influences very well. Its greatest defect is that it contains, occasionally, concretions or crystals of iron ore which oxidize and stain the stone, and which spoil the chisels of the workmen who dress it. This sandstone is used for bases to monuments and tombstones, and for building purposes.

CASS COUNTY.

Coal Measure
rocks.

Cass county contains geologically Quaternary deposits, and the Upper and Middle Coal Measures. Possibly the Lower Coal Measures may be found in the valleys of the south-eastern part of the county. The Upper Coal Measures occupy the greater part of the county, including most of the western and northern portions.

THE CLAYS AND THE CLAY INDUSTRIES.

Shales and pot-
ter's clays occur
here.

Soils and alluvial deposits are used for the manufacture of common building brick. Argillaceous shales, and potter's clays occur at a number of localities, but most frequently in the south-eastern part of the county. They are entirely undeveloped at present. Some of the best exposures are in the vicinity of Creighton.

THE BRICK MANUFACTURERS.

The clay.

Pleasant Hill Brick Company:—This company has its yard at Pleasant Hill where it produces common building brick. It was incorporated in the summer of 1888. The clay used is a mixture of soil and alluvium. The plant consists of four clump

kilns, one New Quaker brick machine (wet process) which has a capacity of thirty-five thousand bricks per day, one steam engine, and drying sheds. In 1889 about two million bricks were produced, and in 1890 about one million seven hundred thousand. The average market price of these bricks was five and one-half dollars per thousand.

Sair, Edmund:—Mr. Sair has a brick yard at Harrisonville. It was started in 1885. Common building bricks, only, are produced. The clay used is a mixture of soil and alluvium. The bricks are hand-made. In 1889 about eight hundred thousand were produced. The average market price of these was six dollars per thousand.

Wade, W. A.:—Mr. Wade's brick yard is on Knob creek, at Creighton. It was started in 1885. Common, hand-made brick, only, are produced. The clay used is alluvium. In 1889 about two hundred and fifty thousand bricks were produced.

THE BUILDING STONES AND THE STONE INDUSTRIES.

The building stone of this county is practically confined to the limestones. Of these there are a number of valuable beds ² in the Upper Coal Measures, which are represented in the general section made by Professor Broadhead, by Nos. 74, 78, 79, 83 and 84. Stone is obtainable from these beds suitable for ordinary purposes, and for dimension work. Some of the beds furnish a marble which is easily polished, and is of a handsome color.

The limestones have been quarried, on a small scale, at a number of localities in the county, notably in the vicinities of Pleasant Hill and Harrisonville.

HENRY COUNTY.

Henry county contains geologically Quaternary deposits, Lower and Middle Coal Measures, and Lower Carboniferous Limestone.

² For a description of these beds see Professor Broadhead's report Geological Survey, Mo., 1872, Part 2, pp. 141-2. Professor Broadhead discusses, also, their economic value as a source of supply of building material.

The Quaternary
deposits.

The Quaternary deposits consist of occasional thin sheets of gravel and sand, of soil, residuary clays, alluvium and Loess. The two latter occur abundantly along the valleys, and what seems to be a form of Loess covers wide areas of the prairie with a thickness varying from five to twenty feet.

The Coal Measures.

The Coal Measures occupy the greater part of the county. The Middle Measures are confined to the north-western part, while the Lower Measures occupy the great central area. The Lower Measures are here, as elsewhere, the most important, economically. They are exposed to better advantage in Henry county than anywhere else in the area under consideration, but have also suffered more disturbance. They furnish various grades of clays, clay shales, coal, and a good sandstone for building purposes.

THE CLAY DEPOSITS AND THE CLAY INDUSTRIES.

The Quaternary clays are used at present, in a small way, for the production of building brick, while the Coal Measure clays and clay shales are used extensively in the production of pottery, sewer pipes, and paving brick.

Following are some of the sections which were made at localities where the clays and clay shales, though at present undeveloped, seem worthy of being sampled for the purpose of making analyses and physical tests.

Section at the bluff of Town creek, and the immediate neighborhood, on the north-western edge of Clinton.

	FEET.	INCHES.
Section near Clinton.	1. Chert gravel mixed with soil.....	
	2. Sandstone, yellow and brown, fine grained, micaceous, friable.....	6-8
	3. Ochre, red, soft, with concretions of limonite and hematite (carrying a band of gray plastic clay varying from one to six inches in thickness), suitable for the manufacture of paint.....	2-14
	4. Sandstone, gray and yellow, with red bands, micaceous, grading into a sandy shale at bottom.....	10-12
	5. Potters clay, gray and reddish.....	3
	6. Sandstone, yellow and brown, micaceous, grading into a micaceous shale of alternating yellow and blue colors.	6
	7. Sandstone, argillaceous.....	3

	FEET.	INCHES.
8. Shale, sandy.....		6
9. Shale, argillaceous, sandy at extreme top and bottom...	3+	
10. Sandstone, yellow, hard, micaceous.....	2-6	
11. Bituminous shale, coal and fire clay.....	1	4
12. Sandstone like No. 10.....	1-2	
13. Shale, argillaceous and sandy in places, more argillaceous toward the bottom, carries thin, non-continuous, layers of hematite, much jointed.....	35+	

The above section was made partly along the slope where there are evidences of local disturbance, and it may be slightly in error. No. 13 is probably of value for the manufacture of sewer pipes and paving brick. No. 3 is a paint material, and No. 5 is a possible source of potter's clay.

Section at Gilkerson's ford, township 41 N. 26 W., section 26, N. W. of S. E. quarter. One eighth of a mile above the iron bridge.

	FEET.	INCHES.	
1. Sandstone, gray to yellow, soft, variegated.....	4+		
2. Slope of soil and chert pebbles.....			
3. Shale, yellow, sandy.....	6		
4. Bituminous shale, vegetable mold.....			2-6 Section at Gilker- son's ford.
5. Fire clay, very siliceous, iron stained.....	2½-3		
6. Shale, gray to yellow, sandy toward top.....	5-6		
7. Shale, blue to black, argillaceous.....	3		
8. Sandstone, yellow, soft.....	3-4		
9. Shale, argillaceous.....	3-4		
10. Limestone concretions, more or less replaced by iron, containing a great number of vegetable remains....		3-5	
11. Coal		6	
12. Fire clay, siliceous and ironstained.....	2		
13. Shale, blue, very argillaceous.....	20-25		
14. Coal	3		
15. Fire clay.			

The fire clay of this section can have but little value as a refractory material on account of its impurities, but it might serve, mixed with some of the shale, for the production of sewer pipe and paving brick. The heavy bed of shale, No. 13 of this section, should prove a satisfactory material for the coarser grades of clay products. Clay suitable for sewer pipes.

Just below the ford where this section was made there occurs a thick and extensive deposit of Loess clay suitable for the manufacture of a high grade of structural brick.

Section at Jackson's mill, township 41 N. 26 W., section 14, S. W. quarter of the S. E. quarter. See p. 66.

		FEET.	INCHES.
Section at Jackson's mill.	1. Gravel.....	3	
	2. Fire clay, in places approaching to a potter's clay.....	2	6
	3. Sandstone, ferruginous.....	1	3
	4. Shale, gray, sandy.....	4-4½	
	5. Shale, blue, argillaceous.....	12	
	6. Sandstone, with iron concretions, fossiliferous.....	1	
	7. Shale, blue to black, varying from soft to hard, fossiliferous, much jointed.....	3-3½	
	8. Sandstone, with blue shale intercalated.....	8-10	
	9. Coal.....	2	
	Water level.		

This section is supposed to correspond with the one at Gilkerson's ford, with some variations in the character and thicknesses of the beds.

Fire and potter's
clays of work-
able quality.

The fire and potter's clay, No. 2 of this section, appears to be of workable quality, and suitable for the production of pottery and a low grade of fire brick. The shale beds appear to be of a satisfactory character for the manufacture of sewer pipes and paving brick.

Section on William Grant's farm, township 42 N. 26 E., section 23, N. E. quarter of the N. E. quarter.

Section from the top downwards.

		FEET.	INCHES.
Section at William Grant's.	1. Gravel.....	3	
	2. Plastic potter's clay.....	3-5	
	3. Hydraulic limestone.....	1½-2	
	4. Shale, gray, calcareous.....	2	
	5. Slate, black, jointed.....	1	
	6. Slate, black, rhomboidal joints, called "block" slate..		8-10
	7. Hydraulic limestone in irregular layers and lenticular masses, pyritiferous.....	1	3
	8. Coal.....	2½-3	
	9. Fire clay, stained more or less with iron, carrying a non-continuous thin seam of coal.....	4	
	10. Coal, pyritiferous.....	1-1½	
	11. Fire clay.....	1	
	12. Clay shale, black, fissile, weathering to a soft and plastic mass, pyritiferous.....	4	6
	13. Coal.....		4
	14. Shale, very sandy, filled with the remains of sigillaria..		

Of this section, No. 9 is the only bed which seems to be of any practical value. It will probably make common fire brick, and will do to mix with other clays for various purposes.

The following section was obtained from Mr. J. T. Kirk. It is of a drill hole sunk on his farm which is situated in township 41 N. 26 W., section 24, N. E. quarter of the N. E. quarter.

	FEET.	INCHES.	
1. Soil and drift.....	5		
2. Sandstone	16-17		
3. Limestone, yellow to gray, very hard.....	2		
4. White clay.....	3		Section at J. T. Kirk's.
5. Clay, blue (argillaceous shale?).....	83		
6. Clay, colored deep red, pink and lavender.....	10		

Judging from the samples furnished by Mr. Kirk, No. 6 of this section should be valuable for the manufacture of paints.

Section at Judge J. G. Dorman's farm on Deer Creek, township 42 N. 25 W., section 32, S. E. quarter.

	FEET.	INCHES.	
1. Soil and drift.....	1-3		
2. Fragments of sandstone, and a pink, fossiliferous limestone.....	2		
3. Shale, blue, argillaceous, gritless, grades upwards into a soft, whitish, very plastic clay, probably as a result of decomposition. It carries near the top a bed of ochre and concretionary hematite, which varies in thickness from 4 to 12 inches.	4'+		Section at Judge Dorman's.
4. Coal.....	4-5		
5. Fire clay, sandy, pyritiferous, seam of siliceous iron ore at the top.....	$\frac{1}{2}$ -1		
6. Clay shale, black, soft, pyritiferous.....	2-6		
7. Plastic potter's clay.....	14+		
Water level.			

The bed of ocher and hematite, in No. 3 of the section, occurs here over a wide area. It is quite accessible and is well adapted for the manufacture of paints. The potter's clay, of No. 7 in this section, seems to be of excellent quality, and is said to be six or more feet in thickness.

Section at Hartwell, township 42 N. 27 W., section 21, N. W. quarter of the N. W. quarter.

	FEET.	INCHES.	
1. Soil.....	1-1 $\frac{1}{2}$		Section at Hartwell.
2. Clay, resembling Loess, sandy toward the bottom..	21		

		FEET.	INCHES.
Section at Hart- well.	3. Shale, gray to black, very argillaceous, fissile.....	5	
	4. Hydraulic limestone, fossiliferous.....	1	
	5. Shale, black, hard, fissile.....	2	
	6. "Block" shale, black, hard, jointed.....		6
	7. Coal.....	2½-3½	
	8. Fire clay.		

The clays and shales here could be easily mined in connection with the coal. They seem well adapted for the coarser grades of clay products.

Section at Lewis Station, township 42 N. 25 W., section 9, N. W. quarter of the N. W. quarter; at what is known as the "Good" coal mine.

		FEET.	INCHES.
Section at Lewis Station.	1. Slope of yellow, porous limestone.....		
	2. Limestone, yellow, argillaceous.....	3	
	3. Sandy shale.....	6	
	4. Shale, black, thinly laminated, bituminous, limestone concretions, abounding in fossils at bottom.....	2	
	5. Shale, argillaceous.....	8	
	6. Coal.....	1	4
	7. Fire clay.....	2	6
	8. Sandy shale.....	7	
	9. Sandstone, fine grained.....	2	6
	10. Shales and sandstones, alternating.....	20	
	11. Bituminous shale.....	2	6
	12. Sandstone, black, irregularly bedded.....	2	
	13. Shale, black, argillaceous.....	4	
	14. Coal.....	1	6
	15. Shale, light colored, sandy.....	5	
	16. Shale, argillaceous.....	4	
	17. Shale, black, argillaceous.....	4	
	18. Hydraulic limestone.....	1	
	19. Shale, black.....	1	6
	20. Coal.....	2	8
	21. Fire clay.		

Section on Field's creek, township 42 N. 26 W., section 29, N. E. quarter of the N. E. quarter.

		FEET.	INCHES.
Section on Field's creek.	1. Soil.....	2	
	2. Hydraulic limestone, fossiliferous.....	1	6
	3. Fire clay, highly ferruginous.....	2	6
	4. Shale, black, jointed, filled with small round con- cretions, argillaceous.....	1	2
	5. Shale, black, fossiliferous.....	6	
	6. Coal.....	2½-3	
	7. Fire clay, impure, lower foot ferruginous.....	3	4

	FEET.	INCHES.	
8. Coal and impure fire clay, with one to two inches of coal at the bottom.....	1		
9. Fire clay, siliceous, with remains of sigillaria.....	1		
10. Shale, black, argillaceous, fissile, pyritiferous.....	5		
11. Coal.....		6	Section on Field's creek.
12. Fire clay, impure, sandy.....	2-3		
13. Sandstone.....		6	
14. Clay, carrying near the top about six inches of red paint clay, very plastic near the top where it is weathered, grades into a fire clay at the bottom.....	2+		

THE BRICK MANUFACTURERS.

Morehead, Herbert.— Mr. Morehead has a brick yard at Clinton, which was started in 1885. Hand-made bricks, only, are produced. In 1890 about five hundred thousand were made. The market value of these was about five and one-half dollars per thousand. Product.

The Deepwater Brick and Tile Company.— This company started on a small scale in 1885, at Deepwater, running only a hand yard. In June, 1889, the present company was organized. The product consists of common, paving, stock and ornamental bricks. Drain tiles and sidewalk tiles are also produced. The plant consists of four up draft kilns, one 35 horse power steam engine, one Kells & Son's brick machine, having a capacity of 30,000 brick per day, one Raymond repress for face brick, and one steam crusher. The bricks are dried by direct heat. About three hundred and fifty thousand common brick are made per month. The output of the other products could not be ascertained, but it is comparatively small. Plant and product.

Hendricks, R. W.— Mr. Hendricks has a brick yard in Calhoun which was started in 1877. He produces by hand process. The product consists of common brick and a few fire brick. In 1889 he made about two hundred thousand bricks, but some years his product amounts to five hundred thousand. A residuary clay of a bed of the Coal Measures is used. Product.

The Missouri Clay Company.— This company started at Deepwater, in October, 1890. The product consists of paving and building bricks, the latter being made a specialty. The plant consists of a one hundred horse power engine, two boilers, Plant and product.

one Warsaw perfection brick machine having a capacity of forty thousand bricks per day, three up draft kilns, and three down draft, all rectangular.

The clay used here is from a bed of the Lower Coal Measures. A pit about 30 feet in diameter has been excavated, in which the following section is exposed:—

		FEET.	INCHES.
Section at Deep-water.	1. Soil, black.....	1	
	2. Clay, resembling loess, black and reddish, very tough.	7	
	3. Clay, alternating white and reddish beds, plastic.....	1-2	
	4. Sandstone, soft and laminated.....	1½-2	
	5. Coal.....		1
	6. Fire clay, jointed, stained with iron oxide along the joints, contains remains of sigillaria, purer toward the bottom.....	5	
	7. Clay, plastic in upper part, and stained with iron oxide grading downwards into a fire clay.....	6+	
	All of the clays of this section are used mixed together.		

THE POTTERIES AT CLINTON.

The Clinton Pottery Company:— This company started in 1886. The product includes a general line of brown stone ware. The plant consists of two steam mixers, five wheels, five kilns, of which two are up draft, and three down draft, and a large building containing the engine, and the working and drying rooms. In 1889 121 cars of ware were shipped. In 1890 the output was somewhat increased.

The clay used is obtained on the company's land in township 41 N. 26 W., section 3, N. W. quarter. A bed about five feet thick is worked in an open cut. About eighteen loads of two tons each are removed weekly.

The section at this point is as follows:—

		FEET.	INCHES.
Section at Clinton.	1. Soil, black.....	1	6
	2. Drift and decomposed sandstone.....	1	
	3. Clay, brown yellow, friable and sandy but fissile at base	1	6
	4. Limonite, siliceous.....		1
	5. Clay, lavender, fissile, plastic.....	1	
	6. Paint clay, red.		1-4
	7. Clay, irregularly banded, yellow and drab, sandy.....		8

	FEET.	INCHES.
8. Clay, drab with yellow iron stains, jointed, slightly sandy	4	2
9. Clay, drab, plastic, gritless, fissile.....	1	
10. Slate.		

Material from the entire section here is excavated and then sorted, the best being hauled to the pottery in Clinton.

North & Reeves: — This pottery is located on the Missouri, Kansas & Texas railway, a short distance south of the depot. It was started in 1885. Two up draft, circular kilns are in use. The product consists of a general line of brown stone ware. In 1889 the total product was valued at \$6,000.

The clay used is a mixture of varieties obtained from several localities in and about Clinton. It is all Coal Measure clay.

THE POTTERIES AT CALHOUN.

The pottery industry at Calhoun has declined somewhat in the last few years, there being now only about one-half the number of potteries that were formerly in operation there. At present four potteries are at work.

Calhoun Pottery: — This pottery was started in 1871. The product consists of a general line of brown stone ware, drain tiles and flower pots.

Darby & Sons: — This firm began in 1878. The product consists of a general line of brown stone ware, drain tile and flower pots. Two circular up draft kilns are used. In 1889 an average of five thousand gallons per week was produced.

The clay used comes from Harden's bank.

Underwood & Sons: — This firm began business in 1875. The product consists of brown stone ware of all kinds and a small amount of art pottery, which is custom made. During 1889 an average of five thousand gallons per week was produced. One circular up draft kiln is used.

Jegglin, G. A.: — Mr. Jegglin began business in 1881. He produces a general line of brown stone ware. One up draft circular kiln is used. In 1889 he produced about two hundred thousand gallons.

THE SEWER PIPE WORKS.

Dickey Sewer Pipe Co.: — The works of this firm are situated at Deepwater on the Kansas City, Fort Scott & Memphis railway. Operations were begun in 1886. The product consists at present of sewer pipe, but the company intends in the future to produce paving brick, fire-proofing and terra cotta. In 1889 one hundred tons of clay per day were made into sewer pipes.

Plant and product.

The factory is conveniently arranged, with the clay beds on one side and railway switches on the other. The equipment is in every way modern.

Argillaceous shale used.

The clay used is from a heavy bed of argillaceous shale, which varies very much in character, growing darker in color and more argillaceous downwards; it is jointed, often fissile and plastic, and sometimes resembles a fire clay. It carries thin layers and often large concretions of iron ore. These are thrown out by the workmen who excavate the clay. The clay is worked in an open cut, the entire bed, fifteen feet or more in thickness, being utilized. There is no stripping to be removed.

THE BUILDING STONES AND THE STONE INDUSTRIES.

Coal Measure sandstones chiefly used.

Lower Carboniferous limestones occur in the south-eastern part of the county, being represented by beds of the Burlington group. The beds here will furnish the best of material for lime making and building stone, but at present they are comparatively inaccessible. The Coal Measures of Henry county furnish some excellent sandstone, but practically no limestones for building purposes. The sandstones are widely distributed. Beds in the vicinity of Clinton, and those mentioned in the sections at Gilkerson's Ford and Jackson's Mill, given above, have proven good building material. They are durable and easily worked. Large blocks are obtainable in some localities. The best beds occur near the surface, and need but little stripping.

The stone industries have been little developed, only such operations having been entered into as was due to local demands, there being no material suitable for the shipping trade. No

quarries of sufficient importance to need special description are being worked at present.

JACKSON COUNTY.

In Jackson county are represented the Quaternary deposits, of which the Loess is the most important, and the Upper and Middle Coal Measures. The Upper Coal Measures occupy nearly the whole area of the county.

Formations represented.

THE CLAYS AND THE CLAY INDUSTRY.

Soils, residuary clays, alluvium, Loess, and argillaceous shales occur abundantly. The Loess has its greatest development in Jackson county. On the bluffs of the Missouri river, at Kansas City, it sometimes has a thickness of not less than 85 feet. With a few exceptions, where it is too sandy, the Loess is of good quality for brick making throughout its entire thickness. It is easily worked and makes unexcelled building bricks of all kinds. The soils, residuary clays, and alluvial deposits are more or less available for brick making, but in the presence of Loess they are rarely used, owing to the superior qualities of the latter.

Loess at Kansas City 85 ft. thick

Worked for building brick.

Argillaceous shales are abundant and easily obtained. They are, however, nearly all too impure for manufacturing purposes. Some that appear to be valuable are too highly calcareous to stand burning. One of the argillaceous shale beds, number 72 of the Coal Measure section, is a notable exception to the usual occurrence. It furnishes an excellent material for the manufacture of a variety of clay wares. This bed is further described in the notes on The Diamond Brick & Terra Cotta Co., given below.

Argillaceous shales are of variable value.

THE BRICK MANUFACTURERS OF KANSAS CITY AND VICINITY.

American Brick Company.—This company has two yards, one at the corner of Third and Harrison streets, the other at the corner of Third street and Troost avenue. The product consists of common brick only. The plant includes seven open, clamp kilns, one wire cut-off brick machine, one Adrian brick and tile machine, and one Little Wonder brick machine (having a capac-

Plant and product.

ity, each, of thirty thousand a day), and two engines of seventy-five, and eighty horse power respectively. In 1889 about eight and a half million bricks were produced. In 1890 about two and a half million. Bricks are shipped to Sedalia, Odessa and Concordia.

Diamond Brick & Terra Cotta Company:—This firm has its office in Kansas City but its works are about three miles south-east of the city, on the Kansas City and Southern railway. The chief product is paving brick, but some terra cotta and fire proofing have been made. The plant consists of two up draft, and three down draft kilns (all rectangular case kilns), a Penfield machine for bricks and fire proofing, one dry pan, one eight horse power engine, and a steam dry house. The capacity of the works is thirty thousand bricks per day. In 1890 about two and a half million paving bricks were produced. Most of these bricks were shipped to Omaha, Neb., Wichita, Kan., Sedalia and Joplin, Mo.

The clay used comes from bed number 72 of the Coal Measure General Section, the outcrop being about an eighth of a mile north of the works, and connected with them by means of a tramway. The bed, where worked, is about eighteen feet thick, and is capped with limestone. The upper ten feet is rather sandy and is not mined. The part which is mined consists of an argillaceous shale which varies somewhat in character, vertically, but seems to be fairly persistent in character, horizontally. In some places it is somewhat sandy. The base of the bed is the most argillaceous portion, and sometimes contains a few fossils.

Gates & Brooks:—This firm has a yard at the corner of Second and Cherry streets. Common bricks, only, are produced. The plant consists of four open clamp kilns, one Quaker, and one Martin brick machine, both being soft mud machines. In 1889 five million bricks were produced.

Kansas City & Wyandotte Pressed Brick Company:—This firm has its yard at Riverview on South Fifth street. It produces common, stock and ornamental brick. The plant consists of four open, clamp kilns, one Kenedy Dry Press, one Little Wonder mud machine, a forty-five horse power engine, one

boiler, sheds, etc. In 1889 about three million bricks were produced. In 1890 about two and a half million.

Kansas City Terra Cotta Lumber Company:—This firm has a yard at the corner of Lydia avenue and First street. It formerly produced terra cotta lumber, but at present is engaged only in the manufacture of common brick. The plant consists of five open clamp kilns and four circular up draft kilns, and two Clark mud machines. Plant and product.

Kansas City Hydraulic Pressed Brick Company:—This company has one of the most complete brick plants in the country. It has two yards, one at Guinotte and Allen avenues, the other at the corner of Askew avenue and Seventeenth street. The plant consists, in part, of eight Graves Patent Duplex, eight Winguard, and four common kilns, four hydraulic presses, (three of which have a capacity of forty-five hundred bricks per hour, and one of twenty-five hundred per hour) and six engines having a total of five hundred and twenty-five horse power. The product consists of common, stock, paving and ornamental bricks of all kinds. In 1889 a total of about twenty million bricks was produced, and in 1890 a total of about twenty-one million. Bricks are shipped to many different States, ranging from Texas to Washington.

Mense-Newman Brick Company:—This firm has its yard at the corner of Troost avenue and Fifth street. The product consists of common building brick. The plant includes three open, clamp kilns, and drying sheds. The bricks are made by hand. In 1889 four million bricks were produced, and in 1890 two million.

Murdock, Robt. B.:—Mr. Murdock has a brick yard at No. 422 West Sixth street. The product consists of common and stock brick. The plant comprises four open, clamp kilns, sheds, etc. The bricks are made by hand. In 1889 three million common bricks, and five hundred thousand stock bricks were produced. The product in 1890 was about the same as in 1889.

Norcross Bros.:—This firm has its yard at the corner of Broadway and Second street. Common bricks, only, are produced. The plant consists of four open, clamp kilns, one Pott's horizontal mud machine, and one stock brick machine. The

total capacity of the plant is forty thousand bricks per day. In 1889 about four million bricks were produced.

Randall, Wm.:—Mr. Randall has a brick yard at Independence where he makes a common building brick. He manufactures by hand and for burning uses three open, clamp kilns. In 1889 he produced about one million * bricks, and in 1890 about the same

Seddon & Edwards Brick Company:—This firm has its yard at the corner of Gillis avenue and First street. Common brick, only, are produced. The plant consists of four open, clamp kilns, one Adrian stiff clay brick and tile machine, with a capacity of thirty thousand bricks per day, one twenty horse power engine, sheds, etc. In 1890 seven million bricks were produced.

Standard Brick Company:—This firm has a yard near the crossing of Alexandria street and the Belt Line railway. Common brick, only, are produced. The plant consists of two open clamp kilns, one Sword & Son, one Wallace and one Martin brick machine. In 1890 one hundred and fifty thousand bricks were produced. This yard, when visited, had but just started, and only one trial burning had been made.

Strust, Wm.:—Mr. Strust has a brick yard at Independence. He produces common brick only. The bricks are made by hand, and two open clamp kilns are used for burning. In 1889 he produced six hundred thousand * bricks.

Stuckenberg, H. H.:—This firm has a yard at the corner of Lydia avenue and Fourth street. Common stock bricks are produced. The plant consists of four open clamp kilns and one Wallace mud machine.

Triphammer, O. K., Brick Company:—This firm has a yard situated on the corner of Broadway and Twenty-sixth street. Common brick, only, are produced. The plant consists of four open, clamp kilns, and one trip hammer brick machine, with a capacity of forty thousand bricks per day. In 1890 three million bricks were produced.

Underwood, Drury:—Mr. Underwood conducted a brick

* Estimated.

yard on Lydia avenue between Second and Fourth streets. Common and stock bricks were produced. The plant consisted of seven open clamp kilns, two Lyon dry presses and a Martin mud mill. In 1889 ten million common, and two million stock bricks, were produced. This yard has been closed, owing to the death of the proprietor.

POTTERIES.

There are a number of dealers in pottery at Kansas City, but the only producer in Jackson county, at present, is the following: —

Kansas City Pottery Company:—This company has its works at the corner of Nineteenth and Walnut streets. It began business in 1888. The product consists of flower pots, vases, baskets, yard ornaments and a general line of brown stone ware. The plant consists of a building containing work, drying and storing rooms, three flower pot machines, four wheel machines, steam engine and crusher, and one circular up draft kiln. The greater part of the clay used comes from Brownington and Calhoun, both in Henry county. In 1889 forty thousand gallons of jars and jugs were produced, and also about thirteen thousand dollars worth of flower pots and vases.

SEWER PIPE WORKS.

Kansas City Sewer Pipe Company:—This company has its works on the C. & A. and Mo. Pac. railways, at the corner of Guinotte and Cleveland avenues in the northern part of Kansas City. The product consists wholly of sewer pipes. The plant is a modern one, and the only drawback to the industry is the fact that it has to ship its clay from distant points, most of it coming from Henry and Jackson counties. In 1889 about thirty thousand tons of clay was manufactured into sewer pipes.

THE BUILDING STONES AND THE STONE INDUSTRY.

The supply of building stone is confined to the layers of rocks included between Nos. 71 and 99 of Prof. Broadhead's general section. These layers vary from one foot to thirty feet in

thickness; they furnish a material suitable, only, in most cases, for common purposes. Some of the layers, however, are occasionally thick bedded, and permit the quarrying of a good dimension stone, in large sized blocks.

Stone suitable for common uses.

Nearly all of the active quarries in the county are in Kansas City, where they are operated under the stimulus of the large local demand. These quarries are so similar in character as to need no individual mention, beyond the facts which appear in the statistical table at the end of this article. They are all, practically, openings in the sides of the bluffs and hills, and they are rarely worked to any considerable depth, owing to the rapidly increasing amount of stripping as the hill or bluff is penetrated.

Quarries similar in character.

Plate V.

On the opposite page are two illustrations of typical quarries in the Upper Coal Measures, at Kansas City. That of the Weston quarry shows the thin, irregular beds of stratum No. 98, and a thick, typical bluff stripping of Loess. That of the north bluff quarry illustrates well the occurrence of the lime-stones where interbedded with shale.

JOHNSON COUNTY.

The formations of Johnson county include the Quaternary deposits, and the Lower and Middle Coal Measures. The Quaternary deposits consist of the usual Loess, soil, alluvium and residuary clays. The Lower Coal Measures, generally speaking, occupy the eastern part of the county, and the Middle Coal Measures the central and western parts.

Formations represented.

THE CLAYS AND THE CLAY INDUSTRY.

The Quaternary clays are suitable, only, for common brick making. Along the outcrops of the Lower Coal Measures, however, are numerous beds of fire and potter's clay and clay shales. These furnish the material for the clay works at Knobnoster and Montserrat. At Knobnoster a bed of fire clay and shale is worked in an open cut, the product, amounting to about four-

Fire, potter's and brick clays occur.



FIG. 1. A view of the Weston Lime quarry. Illustrating a Kansas City quarry with Loess stripping.



FIG. 2. A view of a north bluff quarry at Kansas City. Illustrating a bluff quarry with the limestone interbedded with shale.

11-11-11

teen thousand tons annually, being shipped to Kansas City, where it is manufactured into sewer pipes.

THE BRICK MANUFACTURERS.

Knobnoster Mining and Manufacturing Company.— This company has its works located at Knobnoster. It was incorporated in June, 1890. Common, fire and vitrified paving bricks are produced. The plant consists of two up draft rectangular kilns, one forty horse power engine and boiler, one pug mill, one Wallace mud machine, and one hand repress. The clay used comes from a bank of fire clay and shale of the Lower Coal Measures, in the immediate vicinity. Plant and product.

Montserrat Mining & Manufacturing Company.— The works of this company were situated at Clear Fork station on the Missouri Pacific railway. They were destroyed by fire in 1890, and have not yet been rebuilt. The product consisted of paving brick, drain tiles, fire-proofing terra cotta lumber and a few fire brick. The plant was valued at about thirty thousand dollars. The clay used was taken from a bank at the rear of the works. It consists of an eight foot bed of fire clay and a four foot bed of argillaceous shale, the former overlying the latter. For fire-proofing and fire brick the bed of fire clay was used exclusively, but for other products the fire clay and shale were worked together. The value of the annual product amounted to about forty thousand dollars. These works were well situated, and were supplied with a good quality of clay. The clay used.

DRAIN TILE WORKS.

Montserrat Tile Company.— This company has works located at Montserrat station on the Missouri Pacific railway. It was established in 1886. The product consists of drain tile of all sizes. The plant comprises a building for the machinery and drying rooms, one Chandler & Taylor tile mill (which has a capacity of four thousand three inch tiles per day), one rectangular up draft kiln, wagons, tools, etc. The clay used is from an extensive deposit of argillaceous shale. It is worked in an open cut. The working year is from March to December. In 1889 about twelve thousand three inch tiles were produced. Plant and product

THE BUILDING STONES AND THE STONE INDUSTRY.

The Warrensburg
sandstone.

The building stones of Johnson county having a commercial value are sandstones. These are widely developed, and are known as the Warrensburg and the Carbon Hill sandstones. The former is, by far, the best known sandstone in the State, and it has enjoyed a wide sale for years, being used in many large public and private buildings. The demand for it has, however, fallen off lately. This sandstone formation is a hundred feet or more thick. It varies rapidly in the character of its bedding, in places being strongly cross bedded. The color of the stone varies from gray to brown, but, as used, is generally of a gray color, which is of uniform, handsome appearance. It is often calcareous, highly micaceous, and quite friable. It contains, frequently, large nodular masses of siliceous iron ore, and pockets of bitumen, and of argillaceous matter.

The Carbon Hill
sandstone.

The Carbon Hill sandstone occurs in the Lower Coal Measures. It is from five to eight feet in thickness, and is well marked throughout the county. Its color is buff and brown. It is soft and easily worked. It has been quarried only for local uses, such as foundations, bridge abutments and so forth.

The quarry dimen-
sions.

Bruce Quarry Company.— This company works two sandstone quarries in close proximity to each other, just north of Warrensburg. Both quarries are sunken. One is thirty-five feet deep, two hundred and fifty feet long, and one hundred and thirty feet wide; the other is fifty feet deep, five hundred and twenty-five feet long, and one hundred and thirty-five feet wide. The stripping varies from six to eighteen feet in thickness, and consists of soil and decomposing sandstone.

The stone used.

The stone has frequent flaws, and consequently a great deal of waste material is handled. Its color varies from a light to a brownish gray. It is micaceous and calcareous, and is very soft when quarried, but hardens somewhat on exposure to the air. It varies in the quality of durability, in different parts of the quarry, and some of it appears to be inferior in this respect. Its refractory qualities are excellent. The product consists wholly of dimension stone and blocks of any desirable size are obtainable.

The plant consists of one sixteen horse power engine, and a twenty-five horse power boiler, one steam pump, four channeling machines, wagons, sheds, office, blacksmith shop, three steam derricks, and one horse power derrick. The Plant.

Pickel, Jacob: — Mr. Pickel has a quarry in the vicinity of the Bruce quarries, which has been worked for twenty-two years. It is connected with the Missouri Pacific railway by a switch, two and one half miles long.

The quarry is about sixty feet deep, and exposes from fifteen hundred to two thousand feet of rock face. The character of the stone is similar to that described in the Bruce quarry. The product consists of both sawed and rough dimension stone. The Plant and product. The plant includes three channeling machines, four steam engines (having a total of one hundred and fifty horse power), one steam traveler, seven steam derricks, one steam pump, wagons, platform cars, sheds, blacksmith shop and office. Since the quarry was opened about one hundred thousand cubic feet of dimension stone have been produced. One fourth of this was sawed, the rest sold in the rough.

LAFAYETTE COUNTY.

In Lafayette county are represented the Quaternary and Coal Measure formations. The Quaternary deposits are similar to those in Jackson county. The Coal Measures are represented chiefly by the middle beds which occupy nearly the whole area of the county. A few patches of the Upper Coal Measures occur in the Western part of the county. Formations represented.

THE CLAYS AND THE CLAY INDUSTRIES.

These consist, in the order of importance, of Loess, argillaceous shales, soils and alluvium. The Loess is here, as in Jackson county, the most valuable, economically. The shales and, at least, some of the so-called fire clays are highly calcareous, and need to be burned with great care to yield a product of any value. They are widely distributed. The Loess the most valuable.

Clay taken from below the Lexington coal bed has been ship-

Many clays too
calcareous.

ped to Kansas City to be used in the manufacture of sewer pipes. This clay is too highly calcareous for use except in mixtures with other less fusible clays and, therefore, the industry has probably no prospects of very great enlargement. Two or three attempts have been made to utilize some of the argillaceous shales by manufacturing them into paving brick; none of these attempts, however, have been crowned with any great success. Building bricks are manufactured from the Quaternary clays in quantities sufficient for local demands.

THE BRICK MANUFACTURERS.

Berry, Robert: — Mr. Berry has a brick yard at Lexington, where hand-made brick, only, are produced. Two up-draft, case kilns are used, having a capacity of about two hundred thousand each. In 1890 fourteen million bricks were produced valued at about six dollars per thousand. The clay used is Loess.

Bird and Company: — This firm manufacture common building bricks at Higginsville. They make by hand only, using soil, and subsoil to a depth of about two feet for clay. Two up draft case kilns are used. The product is a rather soft porous brick.

Farrar, Geo.: — Mr. Farrar has a brick yard at Lexington, where both hand and machine made bricks are produced. The plant consists of two up-draft case kilns, having a capacity of two hundred thousand each, one twenty-five horse power engine, one hundred and twenty-five horse power boiler, and one Boyd dry press machine. In 1889 and in 1890 twelve million bricks were produced each year. Their average value was eight dollars per thousand.

Krumsiek, H.: — Mr. Krumsiek has a brick yard and tile works one-fourth of a mile west of Corder. Work was begun here in 1886. Building brick and drain tile are produced. The plant consists of one Phoenix horse power brick and tile machine, two circular up-draft kilns, sheds, etc. In 1890 about five hundred thousand bricks, and two hundred and twenty-five thousand feet of drain tile were produced.

Neaman, Gottlieb: — Mr. Neaman manufactures common building bricks and drain tiles, at Alma. The works were estab-

lished in 1889. The plant consists of a Penfield brick and tile machine, one up-draft case kiln, and drying sheds. The clay Plant and product. used is soil and subsoil. In 1890 one hundred and fifty thousand bricks and one hundred thousand tiles were produced.

Shafermolte: — Mr. Shafermolte has a brick yard at Higginsville, where he produces common building brick. The bricks are made by a Penfield stiff mud machine. Two up-draft case kilns are used. The clay worked is soil and shale.

THE BUILDING STONES AND THE STONE INDUSTRY.

Both limestones and sandstones occur. The sandstones are quarried systematically, but the limestones are worked in a small way, locally, to be used for foundations. The beds of limestone which are so worked come from immediately above, or below, the Lexington Coal bed. Sandstones chiefly worked.

Davis, D. H.: — Mr. Davis has a sandstone quarry situated in township 51 N. 24 W., section 18, east half of the northwest quarter.

The quarry has a face about one hundred and forty-five feet long, and exposes, vertically, about twelve feet of sandstone. The bed is cut by vertical joint planes which are about five feet apart. Its maximum thickness is twelve feet, but it is usually parted by a bedding plane so that the largest block ordinarily obtainable is about five feet thick. Blocks of stone five by five by four and a half feet in size are readily obtainable, and one of these dimensions may be increased, sometimes, to ten feet. The sandstone when dry has a yellow color. When freshly quarried it is brownish, very soft, and easily worked. There are numerous ferruginous streaks running through the bed. Quarry dimensions. Stone soft and brownish.

About four thousand five hundred cubic yards of stone have been removed from the quarry. Of this amount, about one thousand yards went to waste. One half of the remainder was used locally, and the other half was shipped away by rail. The following is the section made at the quarry, in descending series: — Product.

	FEET.	INCHES.	Section.
1. Slope of stripping.			
2. Limestone, blue.....	1	3	
3. Shaly sandstone.....	1	3	

	FEET. INCHES.
4. Sandstone.....	12
5. Shale, dark colored, sandy.....	20+

Quarry material and dimensions. *Railroad Sandstone Quarry.* — This quarry is situated on the J. C. & B. branch of the Missouri Pacific railway, township 51, north range 26 west, Section 23, middle of the north-west quarter of the south-east quarter. The quarry is twelve hundred feet long, but the available face is only seven hundred and fifty feet long. The stone is irregularly stained with iron, is soft and easily crumbled. The sandstone is about twenty feet thick, but the lower ten feet, only, is workable. This lower part is divided into three layers of equal thickness, which are strongly cross-bedded in places.

The following is the section obtained here, in descending series: —

	FEET. INCHES.
Section. 1. Soil and clay.....	10
2. Shale.....	10
3. Shaly sandstone.....	10
4. Sandstone, the workable part.....	10

VERNON COUNTY.

Formations represented. Vernon county is represented, geologically, by Quaternary deposits, Lower Coal Measures, and Lower Carboniferous Limestone. The Quaternary deposits are everywhere present and are similar to those of the adjoining counties. The Lower Coal Measures occupy nearly the entire area of the county. Members of the Keokuk group of the Lower Carboniferous Limestones, reach the surface in the south-eastern part of the county and in several isolated places.

THE CLAYS AND THE CLAY INDUSTRIES.

Materials available. There is an abundance of Loess and alluvium in this county suitable for high-grade brick making. The Lower Coal Measures, which occupy so much of the county, carry numerous, and often heavy beds of argillaceous shales and potter's clays, and several beds of fire clays. The fire clays are so ferruginous as to make them unimportant except for ordinary fire brick. The

potter's clay and argillaceous shales are apparently well adapted to the manufacture of pottery, sewer-pipe, paving brick, etc. Materials available. The shales and clays are more or less favorably exposed at the numerous coal mines in the county, and along many of the streams.

At the Sebree coal pit, near Nevada there is an exposure of argillaceous shale varying from eight to twelve feet in thickness. It is overlain by a few feet of Loess-like clay, above which is a bed of pebbles (Drift), varying from six inches to two feet in thickness. The shale is very argillaceous and is mostly free from grit, but has occasional concretions of iron ore, and patches of bitumen, and grows darker in color toward the bottom where it is quite bituminous. Exposure at the Sebree pit.

At Carbon Center there is a bed of fire-clay, over-lying the coal. It is micaceous and contains too much iron pyrites to be of much value as a refractory clay. Above this are beds of argillaceous shale. They are irregular in extent and thickness, but, altogether, there is a great quantity in the vicinity. It is fissile, gritless and varies in color from gray to black. At Carbon Center.

One mile west of Walker, at Judge W. H. Prewitt's coal bank, about twelve feet of argillaceous shale is exposed. This shale varies rapidly in character. In color it changes from a light gray to a dark brown or blue. It is fissile, dense and gritless in some places, while in others it is coarse and gritty. The seams in the shale are frequently filled with iron ore, which, however, could be easily thrown out in mining. There is an extensive deposit here of this shale. At Judge Prewitt's

In one of the mounds of the vicinity on the farm of Mr. J. J. Morse, near Fair Haven, there is an exposure of potter's clay three feet or more thick. It is plastic, tough, gritless and of a general cream color, mottled with specks of an iron oxide. Near Fair Haven

At some of the coal mines at Moundville there are exposures of an argillaceous and sandy shale which is twenty feet thick and which grades downward into a hard, brittle and dark colored slate. It seems to underlie a wide extent of country. There are also some thin beds of fire clay exposed here. At numerous other points in the county the same, or similar, beds occur and are frequently exposed. At Moundville.

THE BRICK MANUFACTURERS.

Daly, Albert: — Mr. Daly has a brick yard at Nevada which was started in 1884. The plant consists of a pug mill, a Chief brick machine (wet process) with a daily capacity of thirty-five thousand, drying sheds, two clamp kilns and office.

The clay used is probably a form of Loess. It is sandy in places, but is workable to a depth of fifteen feet. In 1890 two and a half million brick were produced.

Mines and Shepherd: — This firm have a brick yard at Nevada, on Clay street, at the M. K. & T. railway tracks. Hand made building bricks are produced. Two up-draft clamp kilns, a repress, and drying sheds constitute the plant. The clay used is a form of Loess. It is worked at present to a depth of six or seven feet. In 1890 half a million bricks were produced.

POTTERIES.

Martin and Sons: — This firm has a pottery at Deerfield, which was started in 1888. The product consists of a general line of brown and light stone ware, flower pots and drain tiles. The clay used is an ordinary plastic potter's clay, cream-colored, stained with iron oxide. It comes from the Lower Coal Measures, about a mile and a half from Deerfield. One circular up draft kiln is used. In 1890 about forty thousand gallons of stone-ware were produced.

THE BUILDING STONES AND THE STONE INDUSTRY.

The building stones of Vernon county occur as sandstones and limestones. There are occasional workable beds of sandstone in the Lower Coal Measures, and there is an extensive and very thick sandstone which is worked at several localities in a small way. The Keokuk limestone will furnish a good building stone, and material for lime-making. The out crops are so far from railroads, however, that no regularly worked quarry has been opened in them, with the exception of one on the Osage river, west of Shell City, where the stone is burned to lime.

Coal Measure
sandstones
worked.

THE STONE QUARRIES.

Anderson, Gustave: — Mr. Anderson has a sandstone quarry at Nevada, which is worked in a small way, as an open cut in a hill side. The formation seems to be the same as that at Warrensburg, but the quality of the stone is, perhaps, better, there being fewer flaws in it. The stone is fine-grained, rather loosely cemented, light gray and brown in color, and can be quarried in large sized blocks. The quarry has an open face eighteen feet high and fifty feet long. It is worked by hand drilling and blasting. In 1890 about five thousand feet of building stone were quarried. Quarry dimensions, material, and plant.

Gilfillan Stone Co.: This firm has a sandstone quarry in Deerfield township and is connected with the Minden branch of the Missouri Pacific railway, by a switch, one mile and a quarter long. It was opened in 1885. The product consists of dimension stone and flagging. The quarry is a sunken one, forty feet deep, two hundred feet long, and sixty-five feet wide. The stone resembles the Warrensburg stone and possibly belongs to the same formation. The lower layer varies from twelve to sixteen feet in thickness and furnishes the best quality of stone. The upper layers are not desirable. From the action of the weather large scales of stone fall from exposed surfaces. The product.

The stone is frequently cross-bedded and, in places, there are large nodules of iron pyrites, pockets of decayed vegetable and earthy matter, and pockets of coal, which accompanied the sand at the time of the latter's deposition. Imperfections of the stone.

It is necessary to handle a large amount of waste material in order to quarry much dimension stone here. The largest block ever quarried was fourteen by four feet, in dimensions.

The plant consists of one ten horse power engine, one derrick, one "gang saw," one channeling machine, one steam drill, one steam pump, blacksmith shop and sheds. The plant.

In 1890 about fifty cars of stone were shipped.

Powell, Mitchell & Bowker: — This firm has a sandstone quarry situated thirteen miles east of Nevada. It was first worked in 1890. The layers of stone vary from two to twelve inches in thickness, and blocks may be obtained of any desired size in the The product.

The product. other dimensions. The stone is colored white and bluish and is very hard. The product consists of curbing, flagging and building stone. In 1890 twenty-five thousand square feet of material was produced.

CONCLUDING REMARKS.

A general survey of the area discussed here shows it to be well supplied with clay and stone building materials, suitable for most of the local needs.

The future of the stone industry. The building stones, however, are, with few exceptions, inferior for cut stone work, or are, at present inaccessible. It is improbable that they will ever form the basis of an extensive industry. Both the conditions of location and the qualities of the stone, will prevent this. For a stone of much commercial value, only the sandstones can be looked to, and the most promising of these, the so-called Micaceous or Warrensburg formation, appears to be too uncertain in character, and too susceptible to weathering influences for any very general development. The best beds seen with reference both to quality and to conditions of occurrence, are in the vicinities of Nevada and Butler.

The future of the clay industry. The clays of economic value are wide spread, almost omnipresent, and of a quality and mode of occurrence, that will permit a great development of the dependent industries. They are specially adapted for the manufacture of terra cotta, building brick of all kinds, pottery, sewer-pipe, and paving brick.

STATISTICS OF PRODUCTION.

Productions of 1889 and of 1890 In the year 1890 the value of the manufactured clay products in this district amounted to but little less than one million dollars. In 1889 it was probably over a million dollars, but was diminished in 1890 by the decrease in demand at Kansas City.

The following tables give in some detail the figures of production of stone quarries and clay works.

STATISTICAL TABLE OF STONE QUARRIES.

FOR THE YEAR 1890.

PROPRIETOR.	LOCATION OF QUARRY.	Number of Stratum used.*	Thickness of Layer.	Face of Quarry Open.	Average Stripping.	MATERIAL QUARRIED IN 1890.				
						Ln. Feet of Curbing.	Perch of Rubble and Footing.	Yards of Riprap and Macadam.	Feet of Range or Cut Stone.	
Adams, P.	Kansas City, 45th and Prospect Sts.	90	90	50	6	600	360			
Anderson, G.	Nevada.	Sand stone	18				5000			
Archer, Mrs.	Kansas City, 35th St. and Jackson Av.	90	90	75	5		800			
Barnes, L. V.	Kansas City, 42d and Locust Sts.	90	6	60	6		800		100	
Berger & Hiert.	Kansas City, 45th and Olive Sts.	90	9	150	6	900	200			
Bohrer, A.	Kansas City, Fairmouth Av. N. of 23d.	90, 92	9.5, 6.0, 2.1	00	8 to 9.6	1000	3600		1800	
Bruce Quarry Co.	Warrensburgh									
Callahan, J.	Kansas City, S. of 43d, W. of Cherry St.	90	6	250	10					
Clarkson	Kansas City, N. Bluff at Cleveland Av.	96, 92, 90	7.4, 1.7, 0	150	5	400	1100			
Cook	Kansas City, West Port.					850	500			
Cummings, R.	Kansas City, N. of Blaine, E. of Bullens St.	90	93	200	15 to 90	500	2200			
Davis, D. H.	Lafayette Co. Sec. 18, 51 N. 24 W.									
Day, T. J.	Butler, 34 m. S. of town								100	
Drinkwater, A. W.	Kansas City, 25th and Grand Av.	98	30	250	2		2000	6000		
Deitz, J. N.	Kansas City, N. Bluff at Brooklyn Av.	98	30							
Fitzpatrick, J.	Kansas City, Brook St., bet. 23d & 24th.	85, 78	800					2250		
Forster, R.	Kansas City, Locust and 43d Sts.	90	6	75	10					
Gillilan Stone Co.	Kansas City, 24th and McGee Sts.	96	6.5	100	28 to 90					
Grady & Finn.	Bet. Nevada & Moundville on the Nevada & Minden Branch R. R.	Sand stone	16	200		about 50 car loads				
Grady, J. J.	Kansas City, 25th and Oak Sts.	90	90	100	8	3000	7000			
Greenwood & Hill.	Kansas City, 24th and Euclide Sts.	96, 90	86	70	20	4000	500			
Hawkinsmith, D.	Kansas City, 25th and Grand Av.	90	90	160		8000	10000		4000	
Holmes, M. M.	Kansas City, 24th and Hardesty Sts.	90	9	150	8	80	160			
Johnson, H.	Kansas City, 26th and Warwick Av.	98, 90	25	400				5000		
Leipheit.	Kansas City, N. Bluff at Elmwood Av.	87	11.6	150	10-87				6000	
Lyle	Kansas City, N. Bluff, E. of Wabash	96, 92, 90, 87	6.0, 1.2, 9.0	400	20-90	600	50	1200		
Lyons, I'	Kansas City, 23d and Fairmont Sts.	90								
Kantzman, A.	Kansas City, 22d and Cherry Sts.	90	9	150	16	5000	3500			
Knoebflein	Kansas City, Agness Av. N. of St. John St.	90	90	100	15	1009	4795			
Kroth & Ramsey.	Kansas City, N. Bluff at Garfield Av.	90, 88, 87	3.3, 4.5, 16.5	200	12-87				1200	
Maloney, J.	West Port, Kansas City, Agness Av. S. of St. John	96, 90, 92	13, 9.1	75		1000	2000			
						700	700		1	

* These numbers refer to Prof. Broadhead's general columnar section, published in the Report of 1872 of the Mo. Geological Survey.

STATISTICAL TABLE OF STONE QUARRIES — CONTINUED.
FOR THE YEAR 1890.

PROPRIETOR.	LOCATION OF QUARRY.	Number of Stratum Used.*	Thickness of Layer.	Face of Quarry Open.	Average Stripping.	MATERIAL QUARRIED IN 1890.			
						Lin. Feet of Curbing.	Perch of Rubble and Footing.	Yards of Riprap and Macadam.	Feet of Range or Cut Stone.
Matt, J. G. & R.....	Kansas City, N. Bluff, W. of Wabash Av.	96, 92, 90, 87	Feet. 6.0, 1.2 9.0	Feet. 625	Feet. 21-96	6000	2000	500	1500
May, J.....	Kansas City, 12th and Summit Sts.								
	Kansas City, 19th and Cleveland Sts.	98						2268	
McBride, C.....	Kansas City, 28th & McGee Sts.	96, 92, 90	95	400	3-96	12000	13000	5000	
Mitchel, W. H.	Kansas City, 31st and Mercer Sts.	90	9	700	7	2100	900		
Miller, G.....	Kansas City, 27th and Hardesty Sts.	90	9	200	8	2000	2000		
Mugan, P.....	Kansas City, 36th and Hardesty Sts.	90	9	200	8	2000	2000		
Mutter, M.....	Kansas City, 28th and Grand Av.	98	25	300				1300	
Nelson, R.....	Kansas City, W. Bluff, 22d St.	96, 92, 90	6.0, 1.5 9.5	300	0 to 96	400	500		
Oberdorff.....	Kansas City, W. of Pullman, about 32d St.	90	90	75	5'-96	600			
Overly.....	Kansas City, Madison Av., 30th-31st Sts.	96, 92, 90	1.4 9.0	300	20-90	700	3800		
Pickel, Jacob.....	Kansas City, Agness Av., Norledge Pl.	96, 92, 90	13 10.5	400	5-96	1900	2700		
Powell, Mitchell & Bowker.	Warrensburg.....							5000	
Pullman.....	13 miles east of Nevada.....	Sand stone	(25,000 sq. feet of flagging, curbing and building stone).						
"Railroad Quarry" ..	Kansas City.....					20000			
Revedon, M.....	Lafayette Co., Sec. 23, 51 N. 26 W.								
Roland & Wilson.....	West Port.....					2000	2000		
Southerland Bros.....	Kansas City, 24th and Woodland Av.	96	5.5	200	26 to 96				
" "	Kansas City, 42d, East of Holmes St.	90	8.5	200	10				
" "	Kansas City, 22d and Forest Sts.	90	8.5	200	10-15	1500	10000		
" "	Kansas City, 27th and Woodland Sts.	96	8.0	100	12				
Schultze.....	Kansas City, 15th, near Manchester		8	100					
Tuttle.....	Kansas City, 16th and Holly Sts.			60					
Turner.....	Kansas City, E. of Pullman, about 32d.	96 90	93	100	5-96	600	500		
Walrond, Mrs. F.....	Kansas City, 43d, W. of Holmes	96	85	75		300	150		150
Welsh, M.....	Kansas City, Agness Av. about Pine St.	90	95	100	15-90		800		
Weston, Wm.....	Kansas City, S. W. Boulevard, W. of State Line.	90	10	100	20	400	3500		
Whalen.....	Kansas City, Pacific and Clairmont Sts.	98		91,250	bu. lime.				
Young.....	Kansas City, Rosidale	90							
	Kansas City, N. of Blaine at Bullens St.	90	93	200	15-90	500	2200		
Total						58,639	109315	28,519	1

And about 50 car loads of curbing and 25,000 sq feet of flagging, curbing and building stone.
* These numbers refer to Prof. Broadhead's general columnar section, published in the Report of 1872 of the Mo. Geological Survey.

STATISTICAL TABLE OF CLAY INDUSTRIES.

BRICK.

PROPRIETOR.	LOCATION OF WORKS.	KIND OF CLAY USED.	NO. OF KILNS.	PRODUCTION FOR 1890.			
				COMMON	STOCK.	ORNA-MENTAL	STREET PAVING.
Anderson, D....	Rich Hill.....		2	650,000			
	Butler.....		5	600,000			
American Brick Co.....	Kansas City.....		7	2,500,000			
	3d & Harrison st.						
	3d & Troost av.						
Berry, R.....	Lexington.....	Loess	2	14,000,000			
Bird & Co.....	Higginsville.....	Soil & Sub-soil.	2	1,500,000			
Daly, A.....	Nevada.....		2	2,500,000			
Diamond Brick & Terra Cotta Co.....	Kansas City.....		5				2,500,000
	3 m. s. e. of City.						
Deepwater Brick & Tile Co.....	Deepwater.....		4	4,500,000			
Farrar, G.....	Lexington.....		2	12,000,000			
Gates & Brooks.....	Kansas City.....		4	600,000			
	2d & Cherry sts.						
Harris Bros.....	Kansas City.....		3(?)	3,000,000			
Hendricks, R. W.							
Kansas City & Wyandotte Pressed Brick Co.....	Kansas City.....		4	2,000,000	300,000	200,000	
	River View.						
	S. 5th st.						
Kansas City Hydraulic Pressed Brick Co.....	Kansas City.....		20	1,500,000	6,000,000	15,500,000	
	Guilnotte & Allen						
	Askew av. & 17th						
Kansas City Terra Cotta Lumber Co.....	Kansas City.....		9	240,000			240,000
	Lydia av. & 1st st.						
Knobnoster Mining & Manufacturing Co.....	Knobnoster.....		2				
Krumsiek, H.....	Corder.....		2	500,000			
Mense-Newman Brick Co.....	Kansas City.....		3	2,000,000			
	Troost av. & 5th						
Mims & Shepherd.....	Nevada.....	Loess	2	500,000			
Missouri Clay Co.....	Deepwater.....		6				
Morehead, H.....	Clinton.....			500,000			
Murdock, R. B.....	Kansas City.....		4	3,000,000	500,000		
	422 W. 6th st.						
Norcross Bros.....	Kansas City.....		4	4,000,000			
	Broadway & 2d.						
Randall, Wm.....	Independence.....		3	1,000,000			
Sair, E.....	Harrisonville.....			800,000			
Schrage, H.....	Kansas City.....		2	800,000			
Seddon & Edwards.....	Kansas City.....		4	7,000,000			
	Gillis av. & 1st.						
Shafernotte.....	Higginsville.....	Soil & Shale.	2	500,000			
Standard Brick Co.....	Kansas City.....		4	150,000			
	Alexandria st.						
Strust, W.....	Independence.....		2	600,000			
Stuckenberg, H. H.....	Kansas City.....		4				
	Lydia av. & 4th						
Triphammer Co., O. K.....	Kansas City.....		4	3,000,000			
	Broadway & 26th						
Wade, W. A.....	Creighton.....	Alluvium		250,000			
Totals.....			119	63,140,000	6,800,000	15,700,000	2,740,000

STATISTICAL TABLE OF CLAY INDUSTRIES.

POTTERY, TILE AND SEWER PIPE.

PROPRIETOR.	LOCATION.	KIND OF PRODUCT.	AMOUNT FOR 1890.*
Calhoun Pottery Co.....	Calhoun ..	Brown Stone-ware, Drain Tile & Flower Pots.....	
Clinton Pottery Co.....	Clinton ..	Brown Stone-ware.....	200,000 Gal.
Darby & Sons.....	Calhoun ..	Brown Stone-ware, Drain Tile & Flower Pots.....	260,000 Gal.
Dickey Sewer Pipe Co.....	Deepwater..	Sewer Pipe	Consumed 35,000 Tons of Clay.
Jegglin, J. A.	Calhoun ..	Brown Stone-ware.....	175,000 Gal.
Kansas City Pottery Co.	Kansas City.	Brown Stone-ware.....	20,000 Gal.
Kansas City Sewer Pipe Co.	Kansas City.	Sewer Pipe	Consumed 30,000 Tons of Clay.
Martin & Sons	Deerfield ..	Stone-ware, Flower Pots & Drain Tiles	40,000 Gal.
Miller & Son.....	Butler	Drain Tile, Fire Clay Chimney Flues & Fire Brick.....	50,000 Ft. Drain Tile. 3,000 Ft. Chimney Flues.
Montserrat Tile Co.....	Montserrat ..	Drain Tile	10,000 Drain Tile.
North & Reeves	Clinton	Brown Stone-ware.....	60,000 Gal.
Shafersholte.....	Higginsville	Drain Tile	
Underwood & Sons.....	Calhoun ..	Brown Stone-ware & Art Pottery	200,000 Gal.

* Estimates.

SUMMARY OF PRODUCTIONS:—

Number Gallons of Pottery	955,000
“ Feet of Drain Tile	65,000
“ “ Chimney Flues	3,000
“ Tons of Clay manufactured into Sewer Pipe	65,000

PUBLICATIONS
OF THE
GEOLOGICAL SURVEY OF MISSOURI.
SINCE THE YEAR 1889.

ARTHUR WINSLOW, STATE GEOLOGIST.

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BULLETIN NO. 2.

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BULLETIN NO. 3.

CONTENTS: The Clay, Stone, Lime, and Sand Industries of St. Louis City and County, by G. E. Ladd, Assistant geologist, 80pp. The Mineral Waters of Henry, St. Clair, Johnson, and Benton Counties, by A. E. Woodward, Assistant geologist. 8vo. Paper. 101pp. 4 cuts, 2 maps. Jefferson City, December, 1890.

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CONTENTS: A Description of the Lower Carboniferous Crinoids from Missouri, by S. A. Miller. 8vo. Paper. 40pp. 5 plates. Jefferson City, February, 1891.

BIENNIAL REPORT of the State Geologist, transmitted by the Bureau of Geology and Mines to the Thirty-sixth General Assembly. Small 8vo. Paper. 53pp. 2 small diagrams. Consists of an historical sketch of the progress of geological work in the State, and of a report of progress. Jefferson City, December, 1890.







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